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Promoting Social Skills in Technology-mediated
Communication Contexts

Consideração de Competências Sociais em
Contextos de Comunicação Mediada por
Tecnologia

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Resumo

A comunicação é uma parte vital do nosso quotidiano. É devido à comunicação que somos capazes de nos expressar, transmitindo as nossas necessidades e sentimentos a outros, permitindo a formação de relações entre nós. Infelizmente, a capacidade de comunicar pode ser afetada, parcialmente ou, até mesmo, na sua totalidade, devido a diversas condições. Como a comunicação constitui um passo importante para a inclusão social, dificuldades associadas à capacidade de comunicar podem agir como obstáculos para aqueles que as experienciam, fazendo com que estes confrontem múltiplas adversidades para se sentirem propriamente incluídos na sociedade.

Soluções tecnológicas, desenhadas para auxiliar a comunicação, foram propostas com o principal objetivo de superar défices que obrigam aqueles que apresentem dificuldades na comunicação, a serem confrontados com rotinas diárias constituídas por desafios provenientes dessas dificuldades. Num entanto, apesar da tecnologia apresentar um papel importante em auxiliar utilizadores a ultrapassar determinadas barreiras à comunicação, esta pode também erguer outras, distanciando o utilizador ainda mais de interações sociais reais através da exposição de métodos ao utilizador que contornam passos cruciais que perfazem uma interação real entre pessoas.

Considerando a importância da capacidade de comunicar e as múltiplas aplicações da tecnologia, bem como outras áreas relacionadas com a utilização de competências sociais, por exemplo, e desenvolvendo sobre prévias soluções de auxilio à comunicação para crianças num contexto escolar, este trabalho aborda a aplicação de competências sociais em contextos onde a comunicação é mediada por tecnologia. Para este fim, uma ferramenta com o objetivo de motivar e promover interações sociais frente a frente, bem como a aplicação das competências sociais do utilizador durante essas interações, é proposta, não para atuar como um substituto a interações sociais diretas, mas sim como um instrumento para as suportar e potencialmente ensinar e melhorar essas competências. Com esse propósito, esta ferramenta guia o utilizador através de um conjunto de desafios cooperativos que apenas podem ser ultrapassados interagindo com outros utilizadores. Estes desafios fazem com que o utilizador tenha de aplicar as competências sociais necessárias para a realização de uma interação social básica, reconhecida dessa forma pelo currículo social válido adotado, "Social Compass", cujo objetivo é auxiliar pessoas com dificuldades associadas à interação social. A solução proposta foi testada por utilizadores alvo e profissionais na área da terapia da fala, com resultados promissores.

Abstract

Communication is a vital part of our daily lives. It allows us to express ourselves, our needs and feelings, enabling the establishment of relationships with others. Unfortunately, the ability to communicate can often be partially or, even, fully hindered due to a wide range of conditions. Since communication acts as a crucial step for integration, difficulties associated with communication can act as obstacles to those that experience them, making them struggle to feel included in society.

Technological solutions designed to assist communication have been proposed with the ultimate goal of bridging deficits that bind those with communication issues to challenging routines. Nevertheless, although technology can play an important role in assisting users to surpass potential communication barriers, it may also give rise to others, pushing the user further away from actual direct social interaction and communication by providing methods that circumvent crucial steps of an actual human to human interaction. Taking in mind the importance of being able to communicate and the multiple facets of technology, but also other dimensions such as social interaction, and building on previous work regarding assistive communication technologies for school kids, this work addresses the promotion of social skills in technology-mediated contexts. To this end, a tool designed to motivate and promote face to face interaction as well as the employment of the user's social skills during them, is proposed, not to act as a replacement for direct social interaction, but as an instrument to support it and potentially teach and improve one's social skills. To do so, this tool guides the user through a series of cooperative challenges that can only be surpassed by interacting with others, encompassing the steps to undergo what is defined as a basic social interaction by an adopted validated curriculum, the "Social Compass", aimed to help people struggling with embracing social interactions. The proposed approach has already been tested by actual end users and professionals in the field of speech therapy with very promising results.

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Chapter 1

Introduction

For many species, the interactions between each other and the formation of groups play an important role when it comes to survivability, for example, herbivores living in social groups receive protection against predators through strength in numbers, while predators living in social groups are better suited to bring down large prey than those living solitary lives. In order for these social groups to be formed, communication between the different members of the said group had to happen and although these interactions may not have occurred in the usual form we humans are accustomed to, communication still occurs one way or the other, allowing different groups to be established.

Acting as one of the main pillars of the society we live in, communication is, and will always be, the only way for us human beings to interact with one another, allowing not only the expression of our needs but also making the creation of social bonds possible. Unfortunately, communication being as important as it is, acts as one of the major requirements in the inclusion of current members of the society in it, meaning that being unable to communicate also renders a person incapable of becoming included in society.

1.1 Motivation and Context

As mentioned before, communication-related difficulties may represent barriers to achieve inclusion for those experiencing them, since such issues may give rise to obstacles related to the development and accomplishment of social acts, potentially leading to social exclusion. These issues can be manifested in different ways, one of them being the display of abnormal behavioral patterns. Avoiding eye contact during conversations, reluctance to engage with other people, and non-reciprocal social interests, are all examples of non-standard behaviors related to communicating with others, being considered as symptoms of certain health conditions, e.g., schizophrenia, depressions and autism spectrum disorders ([1], [2], [3]). Unfortunately, the inherent adoption of such peculiar communication behaviors may classify individuals suffering from such conditions, as belonging to minorities where those behaviors are considered the standard, further distancing them from the mainstream.

> "... minority group members face being peripheral in the superordinate context which may motivate either eschewing their subgroup identity or adopting it at the risk of becoming excluded from the mainstream." [4].

Therefore, when possible to be employed, the existence of a tool that promotes communication, consequently diminishing or eliminating the barriers caused by the behaviors associated with

such conditions, helping users feel included while engaging with other groups, by motivating them to undergo social interactions as well as assisting them while doing so, be it physically or mentally, can be a vital resource to foster integration.

Multiple tools designed with that same goal have been developed over the years, trying to assist users in their inclusion process ([5], [6] [7]). A notable example of such a tool is the Adaptive Multimodal Integrated Communication for All (**AMICA**) [8] application developed by Diogo Cunha in the University of Aveiro. **AMICA** aims to assist children with communication and social interaction problems, in their daily lives, especially at school. A crucial feature of this application is that it provides its users with a multitude of options when interacting with it. **AMICA** was designed to be used mostly inside a school environment, and although it allows teachers, students, and their guardians to communicate with each other, its most important feature is the ability for students to answer exercises published by their teachers on **AMICA**, using their preferred method, from the ones available, to do so, making it simpler for the teachers to include every student in the same class activity. A student, for example, when prompted to respond to an exercise published in **AMICA** (with the personalized answer option available), will be able to select alternative answer methods, such as written, drawn or voice recorded. Allowing people to make use of a tool to its full extent, regardless of their abilities.

We believe that tools which design focus is to promote communication and user inclusion may better tackle the problems they aim to solve, related to assisting the user to communicate and interact with others, by engaging users in face-to-face interactions, walking them through, directly or indirectly, the steps necessary for a complete social interaction.

1.2   Challenges

Tools designed with the purpose of assisting the user to communicate and interact with others have existed for decades, taking new forms and continuing to evolve with the goal of reaching, not only specific audiences but every user if possible. Although there exists such a wide range of tools at a user's disposal to help him better communicate/interact, not many are able to address other specific and important issues related to the actual user, exhibiting a small number of ways through which interaction with the system can be performed, not adapting to different audiences and his context, being unable to gather enough information about its user's environment and the user itself, which could make the system aware of the current context, allowing it to adapt to the user and its surroundings.

A particular practice that seems to be common between applications that intend to assist the user communicate and feel included, is the avoidance of features related to the practice of social skills for more natural and fluid interactions. Many of them tend to rely too much on the technology's side of making the process of communication simpler, exposing users to other forms of socialization. such as virtual socialization.

Virtual socialization has been noted in the literature as bringing both positive [9] and negative impacts [10] to its users. Independently of the advantages and disadvantages of its usage, there are natural steps that form what can be designated as a "standard social interaction" that cannot be reproduced through virtual socialization. Such steps involve the distance from each participant involved in the interaction, interpretation of gestures, understanding, and sharing of emotions, among others ([11], [12], [13]).

Even **AMICA**, previously stated as an example of a tool promoting communication and

user integration, exhibits such behaviors. For a tool specifically designed to potentially improve a user's communication towards those around him, promoting only virtual socialization might contribute to an ongoing avoidance of crucial steps that make up a successful, physical, social interaction. We do not want to isolate the person behind the technology.

Therefore, we consider that tools designed to assist its user communicate with others and feel included should focus on incorporating methods to promote physical social interactions, based on existing and validated practices. Social interaction is crucial for integration. Teaching how a proper interaction begins, develops and ends is the basis for it to happen. In this regard, encouraging social activities, through approaches that promote physical interaction, such as games that involve teamwork and motivate the continuation of those interactions, by sharing personal interests, for example, may potentially develop the user's behavior around others, making the inclusion of the user around others easier.

1.3 Objectives

Taking into account the challenges mentioned above, the main objective of this work is to research novel methods to support communications for all and promote inclusion, through the development of a proof of concept, considering existing solutions, directly and indirectly related to the line of investigation in which this dissertation is inserted, and current practices adopted by professionals on the field of speech-language pathology. For this to be possible the following operational objectives were defined:

- Assess the current state-of-the-art for communication, interaction, and integration assistance tools for various audiences that might benefit from them in different domains;

- Understand the strategies used to teach and foster social skills, e.g., in special education contexts;

- Propose approaches able to support direct social interaction mediated by technology according to the researched strategies;

- Materialize the proposed solutions in a proof-of-concept, such as additional features to the communication tool **AMICA**.

1.4 Publications

The work described in this document resulted in an article accepted for presentation at an international conference.

- Miguel Carvalho, António Teixeira, Samuel Silva, "Promoting Social Skills in Technology mediated Communication Contexts: First Results on Adopting the Social Compass Curriculum", Proc. 12th Int. Conf. on Applied Human Factors and Ergonomics (AHFE 2021), pp. 1–8, Springer, [accepted], New York, July, 2021

1.5 Document Structure

The remainder of this dissertation is structured as follows:

- **Chapter 2: Background and Related Work** - From core concepts associated with this dissertation to considerations related to the development of assistive technology, this chapter emphasizes the role of communication regarding social inclusion and how technology can support it, helping its users achieve that goal, as well as previous related work that lead to the creation of this dissertation.

- **Chapter 3: Personas, Scenarios and System Requirements** - The process for understanding the users to whom the poof of concept was developed for, through the creation of personas, scenarios, and use cases, is depicted in this chapter.

- **Chapter 4: Development of the Proof of Concept** - The development process of the proof of concept, including the technological solutions used and the mockup design iterations according to feedback received from computer science students and therapists, is described in this chapter;

- **Chapter 5: Proof of Concept Evaluation** - This chapter reports the results of two usability evaluation sessions regarding the developed version of the proof of concept, with therapists and actual end-users;

- **Chapter 6: Conclusions** - Here, a final overview of the developed work in addition to possible improvements, are given.

Chapter 2

Background and Related Work

Considering the objectives previously specified, we must first define communication, how certain impairments can act as barriers to communication, and the role of technology in tearing them down.

Certain technological developments, such as the "Internet", have lead to the possibility of virtual socialization, allowing people from all over the globe to interact with each other without having to be physically present near them. Although such developments promote communication and interaction between people, even leading to the creation of "social networks", negative consequences related to the replacement of physical socialization and interaction with this kind of communication have been reported, "Our analyses are consistent with the hypothesis that using the Internet adversely affects social involvement and psychological well-being." [14].

Nonetheless, technology is what we make of it, and multiple technological solutions have also been designed to motivate and assist its user when physically interacting and communicating with others, mainly those who present difficulties in doing so, promoting their physical social involvement and consequent inclusion.

The following sections 2.1, 2.2 and 2.3 will contain background related information, while sections 2.4, 2.5, 2.6 and 2.7 refer to information regarding related work.

2.1   Importance of Communication

As mentioned in the introduction of chapter 1, the formation of social bonds is completely dependent on this process, so much so that individuals unable to communicate with others tend to feel displaced when near groups that are able to do so.

Communication, at its core, is the process of exchanging information between individuals or groups, through the usage of a system commonly known and understood by the entities involved. This process can be divided in multiple types, which may vary depending on the author(s). By focusing on multiple sources[1,2,3] (notable examples being [15], [16], [17], [18]), we divided communication in the following types:

- **Verbal** - Information is conveyed through the employment of human language using either channel, speech or sign;

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[1]https://drexel.edu/goodwin/professional-studies-blog/overview/2018/July/Five-types-of-communication/

[2]https://www.indeed.com/career-advice/career-development/types-of-communication

[3]https://www.marketing91.com/five-types-of-communication/

- **Non-Verbal** - Information exchange via non-linguistic representations, such as body language, facial expressions, among others;

- **Written** - Information is represented as human language transcribed to written, typed and/or printed symbols;

- **Visual** - Information is conveyed by using drawings, photographs, graphs, among others.

As a result of this versatility, when a certain type of communication is preferred over the other or it is impossible to make use of it, be it because a person is not able to do so or the environment simply does not allow it, there are alternatives to initiate, continue and terminate the communication process. In crowded places, during popular events such as a music concert or a football match, when trying to transmit a message to either the performers or the players, it is much more effective to write that message on a placard and wave it than it is to shout, simply because being heard in a crowded and/or sizable environment, can be very difficult, especially if not close to the receiving end of the message.

As stated, usually, when the environment is the main obstacle to a certain type of communication, the usage of an alternative type can be the solution to properly convey the information, however, what if the obstacle is not related to the environment itself but with a person involved in the communication process?

2.2 Communication Issues, their impact and how they are managed

In the previous examples, the environment between both the sender and the receiver of the information to be exchanged, acted as an intermediary to make that exchange possible. Therefore, the environment itself does need to understand what is being exchanged for the communication process to be successful.

Independently of the type of communication used, it still continues to be a bidirectional process, meaning that every intervenient must understand the information being exchanged, regardless of the type used to convey it. Consequently, when obstacles related to the exchange of information, originate from their intervenients and not from its intermediary, such as the environment where the communication process took place, switching the communication type being used may not be as simple as previously mentioned or may not even be possible. Such challenges may be represented in the form of physical and/or psychological disabilities.

A person with a physical disability, blindness, for instance, has a condition thatin previous times, would unable her to convey information through Written communication, meaning that the usage of that type of communication between a visually impaired and an un-impaired person would lead to an unsuccessful communication process. The employment of another type of communication, such as Verbal, may permit the exchange of information to successfully happen but the environment in which this process is taking place must allow it as well.

Another example to be considered is when communication involves intervenients that are able to only convey and perceive information through a single type of communication but also through a single channel. Deaf and hard of hearing individuals use sign language to not only communicate with each other but with individuals with no hearing loss as well. In the latter case, it is probable that the un-impaired individual may not understand sign language, leading

once again, to an unsuccessful communication process if no other type of communication or channel can be used.

Other examples worth mentioning are when communication involves intervenients that are able to convey and perceive information through the type of communication being used but may have difficulties while doing so, such as not knowing how to react or respond to the exchange of information or even how to initiate, continue and/or terminate the communication process. Children with special needs, for example, may have difficulties with Verbal and Non-Verbal communication, but this does not mean they are unable to make use of such communication types, only that they might need to learn and/or have assistance while doing so.

2.2.1 Autism Spectrum Disorder

While children with special needs can cover a wide range of communication difficulties, a condition that is particularly illustrative of such communication issues is autism.

Once considered a psychiatric condition, now defined as a development disorder, autism, alongside Asperger syndrome, **P**ervasive **D**evelopmental **D**isorder-**N**ot **O**therwise **S**pecified (**PDD-NOS**) and childhood disintegrative disorder, share similar core symptoms but present different levels of severity, as a result, the 5th edition of the **D**iagnostic and **S**tatistical **M**anual of Mental Disorders (**DSM−5**) [19] combined these four independent diseases into a single label **ASD**. Although **ASD** can be described as a spectrum of closely related disorders, individuals diagnosed to be on this spectrum may exhibit completely different behaviors and abilities.

While symptoms and disabilities related to such disorders can greatly differ from person to person, a set of commonly shared characteristics related to social interaction and communicationmanifested by those on the spectrum can be defined. Such characteristics, according to ([2], involve:

- Reduced sharing of interests or emotions;

- Difficulties taking turns in conversation;

- Engaging in social interaction to achieve specific goals;

- Challenges understanding and/or responding to emotions and social cues;

- Avoidance of eye contact.

The characteristics mentioned above may not be present in every individual on the spectrum, they represent only a small set of possible symptoms, nonetheless, these are enough to impose communication and integration boundaries when trying to integrate in a society where the majority of its members are not accustomed to such behaviors ([1], [3]).

In order to assist those individuals in their integration process, multiple methods have been developed with the purpose of changing and diminishing the occurrence of those same behaviors. Speech therapists[4], whose work focuses on the evaluation and diagnosis of children with **ASD**, as well as medical intervention, emphasize role-playing activities, where the children in the group session are confronted with a variety of scenarios involving social interactions, as

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[4]To find out which methods are used by actual therapists that interact with such individuals, and to better understand why and how those methods are employed, separate interviews have been conducted with different therapists (appendix A on page 74).

one of the methods used to not only develop their skills, especially their social skills but also to make them feel included in a group. Another method employed by them involves the application of validated curricula to help children practice their social skills by answering questions focused on themselves and those around them, alongside questions related to emotion sharing and identification.

The "Social Compass" [11] is an example of a validated curriculum aimed to help children with autism disorder achieve social success. It is composed of 24 step-by-step lessons, divided into 4 modules, each one referring to a specific theme, nonverbal skills, emotions, social problem solving, and "we" skills.

2.3   Assistive Technology for Communication

As stated in 2.1 and emphasized in 2.2, usually, when the environment is the main obstacle to a certain type of communication, the usage of an alternative type can be the solution to properly convey the information, however when the obstacle is related to the person involved in the communication process and not with the environment, more specifically, with a person whose impairments restrict her from using some types of communication, a change in the communication type being used may still not allow that process to occur successfully. A blind person, like the example presented in 2.2, while having a condition that, in previous times, would unable her to convey information through Written communication, is currently able to do so, thanks to assistive technology.

Assistive technology, according to the "Technology-Related Assistance for Individuals With Disabilities Act of 1988" (Public Law 100-407), is:

> "... a necessity that enables them (some individuals with disabilities) to engage in or perform many tasks.".

This definition is further clarified in the "Assistive Technology Act of 1998" (Public Law 105-394):

> "The term "assistive technology" means technology designed to be utilized in an assistive technology device or assistive technology service.".

Both "assistive technology device" and "assistive technology service" are also defined in the mentioned acts as:

- Assistive Technology Device - "The term "assistive technology device" means any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.";

- Assistive Technology Service - "The term "assistive technology service" means any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device.".

As such, technology can then be designed with the purpose of assisting its user. There are multiple examples of its actual application, from video processing for staircase detection to help the blind [20], to purposefully designed computer programs with the objective of helping students with learning disabilities surpass some of their difficulties [21], alongside many, many

more ([22], [23], [24]). Given the multitude of ways technology may be applied to assist its user, we felt the need to focus on assistive technology designed to enable the usage of certain types of communication and/or aid the user in solving communication-related issues.

2.3.1 Technology as a Communication Enabler

Braille writers are perfect examples of assistive technology devices, whose introduction, allowed for individuals with complete vision loss to convey information using Written communication.

Like blindness, other impairments, that would otherwise make certain types of communication impossible, can stop acting as obstacles to communication with the use of assistive technology. A clear example of this is eye gaze tracking. Eye gaze tracking technology represents a communication enabler for individuals with certain conditions, such as Locked-In Syndrome (complete paralysis of all voluntary muscles except for the ones that control the movements of the eyes), making a person whose only ability to communicate is through eye movements, able to convey information using Written communication, for example.

Speech recognition software is another example of an assistive technology, capable of allowing people with certain speech impairments, individuals with cerebral paralysis, for example, to communicate more clearly using Voice communication [25], making what could otherwise be an exchange of information difficult to be understood, perceivable by both ends. Furthermore, technologies such as the previously mentioned, can be combined with others, for instance, text-to-speech, to allow their users a wider range of communication alternatives, mediated by technology, in this case, Verbal communication.

2.3.2 Technology as a Cognitive Prosthesis

Aside from offering individuals alternative ways to enable the exchange of information, technology can also act as a cognitive prosthetic, bridging deficits for the individual in performing certain activities [26]. Numerous articles not only consider this facet of technology a valuable tool for cognitive rehabilitation ([27], [28]), but also present evidence supporting its impact on cognition ([29], [30], [31]). Notable mentions are Cavalier and Ferretti's paper on "The Use of an Intelligent Cognitive Aid to Facilitate the Self-Management of Vocational Skills by High School Students With Severe Learning Disabilities" [32], as well as Cole and Dehdashti's "Computer-Based Cognitive Prosthetics: Assistive technology for the Treatment of Cognitive Disabilities" paper [26], since they clearly emphasize the technology's side of being used in the improvement of one's self-management and self-sufficiency, highlighting the role of technology in helping individuals access the general curriculum.

2.4 Related Work on Assistive Tools for Communication

Multiple solutions, such as the ones mentioned in 2.3 and ([5], [6], [7]), are able to tackle some communication as well as integration issues, unfortunately, a solution capable of solving every single one is very hard or even impossible to be achieved, given the varied nature such an issue can have. Some solutions need to tackle very specific problems while others can be too general, not addressing other peculiar difficulties. For this matter, we will focus on existing technological solutions that are highly reviewed in the market as well as solutions we considered as notable examples in the literature, that aim to assist audiences feel included,

from applications that help users understand how others feel, to alternative tools which aim to allow users better communicate with others.

"**MOSOCO**" is a mobile assistive tool to support children with autism practicing social skills in real-life situations [12].

Figure 2.1: "MOSOCO" application scene

Being such an innovative application, this tool acts as a significant step towards the usage of technology to develop social skills, being one of the sources of inspiration for the development of this dissertation. As this dissertation, it intends to practice the user's social skills according to the "Social Compass".

Although the objective of this tool provides children with autism with interactive features to potentially develop their social skills, it tries to import the "Social Compass" almost directly to a portable device, meaning that, although neurotypical children can also use this assistive tool with others that are not, its usage may only appeal to those with similar social difficulties, since those who do not display them may not be motivated to use them. This aspect of the application may lead to the isolation of groups, composed of children with autism, behind technology.

"**ConversationBuilderTeen**"[5] is a customizable tool that intends to help teenaged children practice social interactions through conversations with virtual peers in typical social situations.
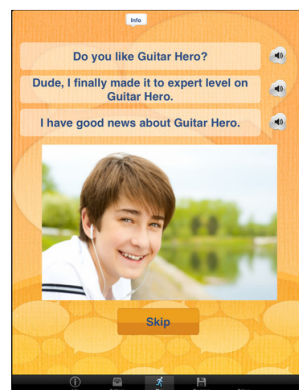
Figure 2.2: "ConversationBuilderTeen" application scene

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[5]https://apps.apple.com/us/app/conversationbuilderteen/id551522479

When exposing users to social situations that involve more complex topics, such as sarcasm and bullying, the reasons why the correct answer is in fact the best response are not always clear, possibly creating the need for additional help in order to fully understand the situation. Grammatical errors present in some of the scenarios may also distract the user from the overall objective. Aside from the mentioned issues, this application is only available on iOS devices.

"**Prism**"[6] is a technological solution designed to help neurotypical people to empathize with those on the autism spectrum by having users experience and practice inclusiveness [33].

Figure 2.3: '
'Prism" application scene

In order to reach a wider audience, sharing this experience with more users, additional options related to accessibility, such as text-to-speech options, should be implemented. This solution would also benefit from the integration of more lessons related to empathy and acceptance.

"**Social Skills with Billy**"[7] is an application that enables children with autism to practice their social skills and pragmatic language skills in age-appropriate situations. Additionally, it also allows users to practice identifying various feelings.

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[6]https://www.etc.cmu.edu/projects/prism/
[7]https://apps.apple.com/us/app/social-skills-with-billy/id1027830019?ls=1

Figure 2.4: "Social Skills With Billy" application main page

Being an application designed to assist users practice and develop their skills, means that feedback related to their performance is crucial to help them understand if they behaved correctly or not. Unfortunately, the app's narrator does not provide automatic feedback, relying on the presence of someone capable of supporting the child's progress and understanding of an expected vs unexpected response. In case of an incorrect response, the user is also not able to simply try again which may be frustrating for some.

As with "ConversationBuilderTeen", "Social Skills With Billy" is also restricted to iOS devices.

2.5 Previous Related Work at University of Aveiro

Being familiar with existing solutions, both fully developed and conceptualized, we will now take into account the ongoing investigation work, by the University of Aveiro, related to the understanding of what solutions have the potential to tackle specific communication-related issues in certain contexts, in which this dissertation is inserted in, focusing on existing technological solutions that resulted from the previous investigation work on improving communication and, consequently, integration of children with **ASD** in environments shared with other audiences.

Those technological solutions, as mentioned, focus on integration and communication issues, more specifically related to children with **ASD** when placed in environments shared with other audiences. Such solutions directly paved the way for the creation and development of this dissertation, by first understanding the target audience ([34], [35]), children with **ASD**, applying the acquired knowledge regarding the target audience into a proof of concept which children with **ASD** might benefit from, "Tell Your Day" ([35], [36]), and exploring context-specific tools to allow an application to adapt to its user in order for interaction to occur in a multitude of ways, assisting users from different audiences feel included in the same environment and, at the same time, providing methods to simplify the sharing of information between family and colleagues (**AMICA**). Those tools are described below.

"Tell Your Day"

"Tell Your Day" is an application, developed by the University of Aveiro, that aims to help autistic children improve their communication with others, adopting multimodality as a base feature.
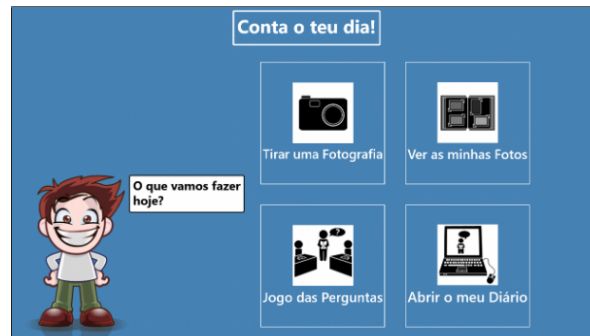
Figure 2.5: "Tell Your Day" Main Page.

An important aspect of this application is the presence of a companion character, a virtual avatar with which the user can interact with while using the application. By interpreting that avatar as a friendly character, and not as an actual person, a child may find it easier to interact with it.

From the 4 major features present in "Tell Your Day", there are two that promote the user's direct/indirect contact with others, a quiz game and a diary that represents a restrictive view of a social network.

The quiz game is supposed to be played with two devices, one for the child and the other for the teacher. During this game, the child has to answer questions proposed by the teacher. The questions are proposed and answered through the devices, not out loud. Aside from being able to ask questions, the teacher is also able to make use of the animated character, from his device, to talk with the child.

The diary feature allows the child to interact with a minimalist interface of an online social network, in which only a small set of actions related to the child profile, are enabled. The available set of actions is enough for the child to share their interests with her friends and family, allowing her to post images and comments in a shared space, being able to reply to other posts and comments as well. This restrictive view was considered taking in mind the child's safety, not exposing her to most unknown and possibly harmful content.

Although these features promote important behaviors for social interaction, such as the sharing of interests, these interactions do not occur physically, but virtually, demoting other important aspects of social interaction, for example, eye contact, space and proximity, among others. By doing so, the application is allowing children with **ASD** to circumvent some of their difficulties when communicating, such as making eye contact, instead of assisting them surpass said difficulty.

"AMICA"

Adaptive **M**ultimodal **I**ntegrated **C**ommunication for **A**ll (**AMICA**) is a cross-platform application developed by the university of Aveiro. **AMICA**'s goal is to assist children with

communication and social interaction problems, throughout their daily lives, especially at school.

Figure 2.6: **AMICA**'s Children Application Hub.

AMICA, although developed with children with **ASD** as its focus group, was designed with the main purpose to serve all, intending to serve as a useful tool not only to those with difficulties but to everyone that uses the application, so as to not potentially isolate a specific set of users behind technology but to bring different users closer.

Since **AMICA** was developed based on the concept of being used in elementary schools, it is capable of being used by both children with communication problems and without, by family members, parents, guardians, and teachers. Depending on the user that is interacting with the application, different hubs are presented. There are specific hubs for children, teachers, and family members.

From the features present in **AMICA**, every function promotes the user's direct/indirect communication with others, either by enabling mechanisms that allow for that communication to happen (chat) or by showing information that might motivate the user to communicate with other users (sharing of user-related information).

A big part of those features work together to form a minimalist and restricted social network, where only the teachers, their students, the respective family members and, guardians of the children can access. Children can then share their pictures, drawings, texts, expressions, and voice recordings without worrying about it being seen by people outside of the school environment. Privacy options are still available to only allow the user that created the content to be the only one with access to it. Children can also chat with each other, with teachers, or with their family members and guardians if they desire to do so. While chatting they can send messages as text, images, voice recordings, and drawings.

AMICA tries to take advantage of multiple modalities to address the children's communication issues, enabling children to express themselves in a variety of ways (using text, pictures, their voice) instead of a single one. As emphasized in 1.2, by enabling students to answer exercises, published by their teachers on **AMICA**, using their preferred method to do so from the ones available, helps the process of including two different audiences, children with and without potential communication issues, in the same environment, since everyone may now have at their disposal tools that enable them to take part in a collective objective, allowing them to make their own contributions.

Although this application presents multiple features that allow a user to communicate and

interact with others, that communication and interaction continues to be mediated by a device, once again promoting digital socialization, not emphasizing other important aspects of social interaction. Like "Tell Your Day", "**AMICA**" allows users with potential communication issues, to continue to circumvent some of them, by making it possible to ignore or disregard important steps that make up a real and complete social interaction.

2.6 Design and Development of Assistive Applications

Focusing on the facets of technology explored in 2.3, we are able to conclude that the creation and improvement of technological solutions may be translated to significant improvements in a person's life, but how should such an assistive solution be designed and developed upon?

Regardless of what the solution actually aims to solve, important design concepts must first be taken into consideration during the development process [37]. Since the solution's goal will be to assist its user, it is crucial to involve him during the development process. Although there are multiple design concepts on which the development process can focus, according to [37], **U**ser-**C**entered **D**esign is not only an important design concept when designing a custom assistive technology solution, but when compared to different approaches and other product design philosophies "***UCD*** *tries to optimize the product around how users are able to use, prefer to use, or need to use the product, rather than forcing the users to change their behavior to accommodate the product.*".

Other equally important design concepts referred in [37], are Universal Design and Inclusive Design. Although they can be considered as different design approaches, having different names and individual definitions, they share a common goal, to promote accessibility. According to [38]:

> "*These approaches all take the needs of a broader spectrum of people into account in the design process to ensure that mainstream equipment and services can be used by a wide range of users, including older people and those with disabilities. Awareness of the development of these different approaches that have been presented helps illuminate the challenges and the basic values underlying the general approach towards increased accessibility.*".

There are various ways to enable a system to support a wider range of users, therefore promoting accessibility. The ability for users to choose how they wish to interact with a system from a set of supported modalities (multimodality), for example, is able to make a system usable by different types of users, not only because some users might prefer to interact with the system through a certain method but also because other users may only be able to interact through specific modalities.

2.6.1 Iterative User-Centered Design

When developing anything with the purpose of being used, from simple objects, such as alarm clocks, to complex applications, like design related software, one must bear in mind who will use the system and how will he perceive and interact with it. If we decide to design an alarm clock, for example, we may want to invest in its design in such a way that some users will be pleased by its aesthetics, others will ask themselves why it looks like a microwave, while the rest just wants to know if it actually rings.

From the previous example, we can conclude that different users will most likely find value in distinct aspects of the object/system to be used, aesthetics, functionality, how to interact with it, and many others. While the liking for the aesthetics depends on the user's taste, what the system does and how to interact with it, on the other hand, can be explained through the use of instruction manuals and examples. Although they may help the user better understand the system, in reality, be it because it is very time consuming, tiresome, or simply not needed, not everyone reads and/or understands them. Ideally, the object/system should be intuitive enough, allowing interactions, between user and system, to occur naturally, without the need for anything else aside from the system and a simple look at it.

Therefore, because every user will have their own tastes, experiences, and knowledge, an object/system capable of pleasing every single user is a very difficult task. That is why, when an object/system is being designed, a target market should already be decided, meaning that the product is being developed by considering only certain types of end-users.

With the types of end-users established, all that is left to do is to make sure that the product, after being fully developed, is actually relevant to the user and helps him with the task it was designed for, but a question comes to mind, how is it possible to be absolutely sure about such a thing if the object/system is just starting to take shape?

This is where **U**ser-**C**entered **D**esign(**UCD**) plays an important role, by placing end-users alongside the developers of the system, they are able to directly influence its design, acting as a compass, guiding the developers through the design process, making them sure which are the needs the end-user would like to have satisfied when using the system [39]. In our case, a system being developed with the aim of assisting its users has to be designed for them, taking in mind their actual needs as the crucial requirements of said system.

Each iteration of the **UCD** process is normally divided into 4 different phases [40]:

- **Context of Use** - In this first phase the goal is to identify who will use the product, why they will use it, what will they use it for, and under what conditions;

- **User Requirements** - After specifying the context of use, a phase dedicated to identifying the product users is followed. By knowing the user's requirements, developers are one step closer to creating a successful product;

- **Design Solutions** - The product undergoes a design and development process from its initial concepts to a complete design;

- **Design Evaluation** - Here, ideally through usability testing with actual end-users, the product is evaluated, giving developers information regarding the satisfaction of the user needs.

2.6.2   Personas, Scenarios and Goals

Personas

Personas serve to summarize and represent the target audience of the product being designed.

> "*Personas provide us with a precise way of thinking and communicating about how users behave, how they think, what they wish to accomplish, and why.*"[41]

Although fictional, Personas result from the collected information, quantitative and qualitative, gathered in earlier stages of the design process, acting as reality checks for developers, keeping realistic ideas about the users throughout the design process.

Scenarios

Like Personas, Scenarios also act as fictional representations but instead of representing users, they describe the usage of the product by a Persona to achieve a certain goal.

> "*Persona-based scenarios are concise narrative descriptions of one or more personas using a product to achieve specific goals. They allow us to start our designs from a story describing an ideal experience from the persona's perspective, focusing on people, and how they think and behave, rather than on technology or business goals.*"[41]

Scenarios help developers identify certain aspects related to the usage of the product in the world that would otherwise be harder to detect.

Goals

Goals dictate the motivation of the Persona behind the usage of said product.

> "*Goals serve as a filter for tasks and as guides for structuring the display of information and controls during the iterative process of constructing the scenarios.*"[41]

A Scenario is over when the Persona's Goal is achieved.

2.6.3   Usability Evaluation

In order to understand if what was developed needs to undergo further iterations in order to better tackle the end user's needs, methods to test and evaluate it should be employed.

As mentioned previously, in an iterative user-centred approach, each development cycle is supported by an evaluation stage (Design Evaluation) that supports further developments of the prototype by assessing how its current state satisfies the requirements and if it is aligned with the user needs and expectations. Since a prototype will most likely support different levels of functionality over time, the method selected for its evaluation should be chosen accordingly. Additionally, when the end-users, to which the final product is aimed to satisfy, are an audience difficult to be included in the evaluation sessions, different methods should be used to deal with such constraints.

There are multiple methods available for usability evaluation such as Inspection, Empirical testing, **M**etrics for **U**sability **S**tandards **i**n **C**omputing Various (**MUSiC**) and many others [42]. Usability inspection, or Inspection as referred to before, is not a single method but a generic name for a set of methods characterized by having evaluators inspect the interface [43]. Such methods include heuristic evaluation, cognitive walkthroughs, formal usability inspections, pluralistic walkthroughs, feature inspection, consistency inspection, and standards inspection [43]. The heuristic evaluation method and cognitive walkthroughs are particularly important for this dissertation since they were the method of choice for usability inspection of the developed proof of concept.

The heuristic evaluation technique is the most widely used inspection method [44] and considered the most informal as well [43]. It involves having usability experts review an

interface according to a set of usability principles defined, by Nielsen, as the "heuristics" [43]. It is important to note that heuristic evaluations do not replace actual testing neither do they validate the system paradigm and approach. They act as a way of detecting basic usability issues in early stages of the development process.

In order to test the system being developed, it is crucial to have actual end-users involved, especially when following a design process such as **UCD**. Up to this point, we have assumed that acquiring feedback directly from end users is always possible but, unfortunately, this is not true. There are cases where interacting directly with them may not even be an option, one of the reasons being that the end-users may belong to an audience with which the development team may not be qualified or understand how to interact with.

When situations, such as the one described, happen it might be a good alternative to involve a proxy user instead. Proxy users are not real end-users, they are people who should be able to understand and transmit what the end users would want, up to a certain degree. Although they can act as a valuable source of information, it can also be a dangerous practice, since they still see the end user's requirements through their own perspective, which, unless asked directly to the real users, may not be true. Nonetheless, when contact with the real end-user is not possible, finding someone close to representing them might be the best alternative.

As depicted, not being able to receive feedback directly from the end user represents a potential problem when making important design decisions but, even when it is possible to interact with users belonging to challenging audiences, there are still considerations to be made regarding the audience characteristics and their ability to provide feedback through the tools that were given to them. Certain audiences might struggle to interact with specific devices or behave in ways the system is not ready to perceive, not being able to properly test the developed system. This means that, when including such users in evaluation sessions, conditions must be adapted to them, even if it means changing the system.

When usability tests are made, standardized usability questionnaires in order to assess the participant's perceived usability and satisfaction of the system. Examples of such questionnaires are the **S**ystem **U**sability **S**cale (**SUS**), **S**oftware **U**sability **M**easurement **I**nventory (**SUMI**), and the **P**ost-**S**tudy **S**ystem **U**sability **Q**uestionnaire (**PSSUQ**). Although there goal is the same, to gather user feedback through standardized measurements, their structure and method of scoring a questionnaire differs.

Once again, although these are standard tools that were designed to benefit those looking to acquire feedback, the characteristics of certain audiences may not allow their employment. An example of an audience that may not be able to give feedback through the usage of such tools are children, mainly because they may find the task to fill such questionnaires too complex.

2.6.4 Multimodal Interaction

Every day, purposefully or not, a person is likely to interact with some kind of system. Be it with a mobile phone, a television, or a car, our society has developed to the point where such systems have evolved beyond their main functionalities, cars can hear, televisions are able to see and wristwatches think. What was once a simple to interact with device, designed for a singular purpose, can now be a complex system capable of much more than its initial main function. Aside from the systems themselves, ways of interacting with them and how they respond to the user also evolved.

Human-**C**omputer **I**nteraction(**HCI**) is a multidisciplinary field which main focus is to

study not only the design of computer technology but also its use, how humans interact with the computer itself. Researchers in the field of **HCI** are responsible for numerous improvements and novel ways of interaction between humans and computers. A formidable example is the work described in Richard A. Bolt's paper "'Put-That-There': Voice and Gesture at the Graphics Interface" [45], where a user commands shapes on a graphics display surface, emphasizing "...*how voice and gesture can be made to inter-orchestrate, actions in one modality amplifying, modifying, disambiguating, actions in the other.*"

As it can be seen, the use of multiple modalities can be advantageous for the interaction between the user and the system in question but what exactly is a modality? Although there are multiple definitions, according to Niels Ole Bernsen [46]:

> "*A modality or, more explicitly, a modality of information representation, is a way of representing information in some physical medium.*".

Following Niels Ole Bernsen's definition of modality, a modality is then defined by both its physical medium and its particular "way" of representation. If, for example, we consider light as the physical medium, using our sense of sight, we are able to perceive language text, image graphics, gesture, among others, meaning that through the same physical medium, information representation can be displayed differently, making them different modalities.

Applying the concept of modality to interactive systems, such as the ones mentioned before, we can now say that a system perceives information from the user through one or more modalities (input modalities) and outputs information through the same or different modalities (output modalities). An example of such a system is the smartphone which can be interacted with gestures and language and can output information through text and images. With the concept of modality now present, we can now define multimodality. Because modality was defined according to Bernsen, so will multimodality:

> "*A multimodal interactive system is a system which uses at least two different modalities for input and/or output.*"[46]

A system that can handle multiple modalities is able to not only provide its users with more ways to interact with it but can also make interaction feel more natural than other systems. As mentioned before, Bolt's paper [45] greatly describes the benefits a multimodal system can bring. The fact that, in many occasions such as during a conversation, a person does not feel the need or is unable to specify an object or a location for example, but through a combination of both gestures and speech other people can extract meaning from it, understanding what the other person was trying to convey, implies that the usage of such combinations may act as a preferred alternative when trying to convey information.

Applying said concepts to the problem at hand, the creation of a system designed for integrating different people from different audiences in the same environment, offering users a wide range of alternatives to communicate with interactive systems is extremely important for application adaptation, providing a more personalized usage experience to every user, independently of their particular audience. In this regard, a multimodal interactive system is an important step in developing an assistive application aimed at allowing the integration and joining of multiple audiences.

2.7   Discussion

Applications designed to assist their users, in particular, children with autism, communicate and interact with others, already exist and although they tend to explore different methods to help their users surpass and/or circumvent issues related to communication and social interaction, such application also appear to promote unrealistic scenarios for interaction. Scenarios where the physical presence, of the participants of said interactions, in the same environment is completely avoided, making the interactions between them, sometimes, be summed up to writing a message, clicking send and waiting for a reply. Social interaction is much more than that, it encompasses a series of structured steps that should not be ignored if the main objective is, in fact, to help the user to better communicate and interact with others, and consequently, feel included and integrated when placed within an environment with diversified audiences. Although some solutions focus on social interaction, taking into consideration the steps that compose it, they may fail to make those interactions occur between people from other groups, relying heavily on technology to serve as an instruction manual for interaction.

Taking these considerations into account, an application capable of confronting its users with actual social interactions, to assist in their process of feeling included among the group, by following a validated curriculum that defines the bases on how such interactions should occur, is needed.

Chapter 3

Personas, Scenarios and System Requirements

In accordance with the objectives defined for this dissertation (section 1.3), as well as the practices defined for the design of assistive applications (section 2.6), an iterative **UCD** approach was adopted, leading us to define a set of personas, scenarios and use cases, presented in this chapter. It was decided that the actual use cases, displayed in the form of tables depicting the interactions necessary to occur between the system and the user(s) to make the scenarios possible to happen, were to be placed as an appendix to the dissertation since their details are optional for the understanding of this work. Regardless, a brief introduction of the use cases, related to the displayed scenarios, will be presented. Use cases are displayed in appendix C. Based on the information gathered from the previous steps, a set of requirements, which the system will have to meet, are possible to be inferred.

As mentioned in section 1.3, research and developments made for this dissertation will be represented through the addition of new features to the already existing system **AMICA**, therefore, personas, scenarios and, consequently, use cases, will be defined according to a proper context of use of **AMICA**. For this to happen, the scenarios and use cases will take place in a school environment.

3.1   Personas

The personas depicted in this section were selected to represent the end-users of our proof of concept and how such users benefit from the system to be developed. In the line of investigation which this dissertation is part of, previous works ([35], [34]), even prior to **AMICA**, have focused on the development of applications for children with **ASD**, including, understanding them as end-users through the elaboration of personas representing them and their family. From the set of personas defined in those works, as well as in **AMICA**, we have selected three according to their relevance for this dissertation, Nuno Rocha, a child diagnosed with **ASD**, Gabriel Pereira, Nuno's best friend, and Sofia Rodrigues, teacher of Nuno, and created a fourth one, Érica Beatriz, a new classmate of Nuno and Gabriel. The motivations of the imported personas were changed to better fit this dissertation.
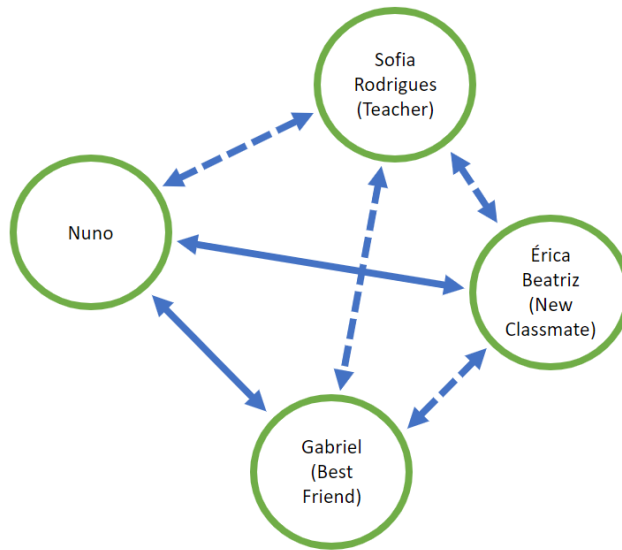
Figure 3.1: The Personas and their relations are presented in figure 3.1, contrasting the interactions, between the Personas, that are expressed in the scenarios (continuous lines) and those that are not (dashed lines)

3.1.1 Nuno Rocha, child diagnosed with ASD

"***Nuno Rocha*** *was born on February 20th, 2005 in Moita, Anadia county, Aveiro district, Portugal. At the age of 2 he went to a development appointment in the district hospital, because his parents suspected that something was wrong with his development, where we was, posteriorly, sent to an autism exam to the Pediatric Hospital of Coimbra. At the age of 3, he was diagnosed with Autism Spectrum Disturbance (level 2 in the scale of severity), with associated cognitive deficits.*
Family: *Nuno lives with his father, mother and a 13 year old sister.*
Interests: *At home, he prefers to watch TV and play computer games, so when he is asked about the professional preferences, he mentions he would like to stay at home with his mother and watch TV or play computer games.*
School: *He currently attends the 4th grade in Anadia's Basic School, where he benefits from a UEE support that delivers him a structured learning model (TEACCH) and the application of interdisciplinary intervention methodologies. It is in the school context that he also benefits from Speech Therapy sessions. Nuno is a student with a specific individual curriculum (that consists of changes to the normal curriculum, mostly consisting on the introduction, substitution and/or elimination of goals and contents). On a daily basis, for 2 hours, he attends the regular class, and the goal is to work in the social sense, whereas functional classes (like functional Portuguese, world knowledge, functional math and every day activities) are learned at the unit.*
ICT competences: *He appears to dominate the basic functions of a computer, however, he only uses his ability to play computer games. He is not able to research information on any search engine, nor does he use the social networks for communication.*
Communication competences: *He appears to understand simple oral material, specifi-*

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cally words or sentences related with his social and familiar day-to-day. On the other hand, difficulties are observed on the comprehension of longer sentences that lack visual support or that are out of the context.

The elected mean of communication is speech. He is mostly capable of using short and simple sentences (subject + verb + object). As far as it concerns reading, he recognizes all the letters from the alphabet, but he seems to struggle on the reading process, mostly syllabic, associated to a loss of purpose and hesitations. He writes with orthographic correction but he needs support on the structuring of small texts and in answering questions. He also presents difficulties using markers and morphosyntatic constituents by omitting link words, such as prepositions, along with difficulties in number/gender agreement for definite articles. He also has trouble in matching the verbal form with the personal pronoun (e.g., "I does").

He makes requests in his areas of interest and when questioned he has difficulties in answering , sharing daily experiences, and beginning and keeping a conversation. He shows difficulties in keeping eye contact and respecting interaction shifts. In some situations, he verbalises incoherent phrases and out of context (delayed echolalia).

Interaction competences: *At school, when he does not recognize his surroundings, he walks front and forward, not addressing the employees for help. He gets anxious every time his routine is changed or when he's thwarted, presenting inappropriate and sometimes aggressive behaviors, as yelling, pinching, and biting whoever is around. He shows attention/concentration deficit, namely failing to pay attention in the classroom, which leads him to easily demotivate if the proposed activity is not of his interest.*

Regarding the daily routine activities (such as dressing and personal hygiene), usually he is able to conclude them with autonomy, requiring, from time to time, supervision to accomplish their sequence."

Motivation: Nuno wants to feel included in the school environment, especially when attending regular class, where he does not know all of his colleagues since he spends less time with them.

3.1.2   Sofia Rodrigues, Nuno's teacher

"**Sofia Rodrigues** *was born in Aveiro on the 3rd of May, 1989.*
Family: *She is single and lives with her parents.*
Interests: *Her main interests include literature, cinema and painting. In her free time, she likes swimming and handicraft. During weekends, she regularly hikes.*
Education: *She has a BSc in Elementary Education and an MSc in Pre-school and Primary School teaching. She has also attended courses on "Detecting Child Abuse" and "Sign Language - Level I".*
Teaching experience: *Presently, she teaches 4th grade students in Anadia's elementary school. She has two years of teaching experience, but only had a child diagnosed with ASD integrated in her regular class for the past seven months. Since her class has approximately 20 students she mentions that it is hard to provide all the support that her student with ASD requires.*
Beyond that, the student with ASD constantly defies her authority refusing to enrol in the proposed tasks and frequently showing opposing behaviours such as shouting and tearing or piercing the worksheet with a pencil. Only on very rare occasions the student establishes eye contact or interacts with her on his own initiative.

In this context, she is <u>not able to perform an active role in his teaching when compared with the special education teacher</u>. In the future, she would like to improve her knowledge in this intervention area.
She already tried to use an application to provide the child with ASD with some features that might help during class, but sometimes <u>she struggled with having to deal with the fact that the application was not also used by the remaining students</u>."

Motivation: Sofia wants to be able to better interact with Nuno and help him in his learning process.

3.1.3 Gabriel Pereira, Nuno's best friend and classmate

"***Gabriel Pereira***, *born on March 1st, 2005, is from Moita, municipality of Anadia, Aveiro district.*
Family: *He lives with his father, mother and two younger twin sisters.*
Interests: *He is a great student who likes all subjects. He has a good knowledge of computer and mobile devices, especially computer games. At home, he loves to text his friends, play computer games with them and play with his little sisters. His favorite extra curricular activities are playing computer games and rollerblading. In the future he wants to create computer games.*
School: *He currently attends the 4th grade at Basic Education School of Anadia. At school, Gabriel is <u>one of Nuno's classmates</u>. They met in kindergarten and <u>have been best friends</u> ever since. However, recently they <u>have not spend much time together</u> because of Nuno's special education classes.*"

Motivation: Gabriel wants Nuno to spend more time with him in school.

3.1.4 Érica Beatriz, Nuno's and Gabriel's new classmate

"***Érica Beatriz*** *was born in Válegua on the 18th of September, 2005.*
Family: *At the age of 10 she and her older brother along with their parents <u>moved to Moita, municipality of Anadia, Aveiro district</u>.*
Interests: *Her main hobbies are listening to music and watching movies. She hopes to be an actress when she grows up. While at home, aside from the hobbies, she always tries to find opportunities to play with her older brother.* **School:** *She started attending the 4th grade at Basic Education School of Anadia and although she is <u>new to the school</u> she has already made many friends. She is very friendly and loves engaging in conversations and activities with others. At school, because friends are never too much, Érica also loves to get to know her classmates, especially the ones <u>she has yet to introduce herself to, like Nuno</u>.*"

Motivation: Érica wants to know Nuno and hopefully engage in fun activities with him.

3.2 Scenarios

After defining the personas, multiple scenarios describing the usage of the conceptualized system, by those same personas, were created. The scenarios displayed in this section were

selected among all the scenarios created (appendix B). These were chosen because they depict crucial interactions between the established Personas.

In the upcoming scenarios, the personas are already familiar with **AMICA** and will be interacting with a novel version of it, to assist them towards their motivations. Scenario 1 (subsection 3.2.1) depicts Érica's interaction with the application to see hers and other friends' profiles, editing her own as well. In scenario 2 (subsection 3.2.2), by using the application, Gabriel notices that Nuno is already at school and decides to check his sticker collection and undergo a challenge with him. Scenario 3 (subsection 3.2.3) describes Nuno's interaction with the application by seeing his own sticker collection, undergoing a different challenge with a friend, and getting information related to that friend's interests.

3.2.1 Scenario 1 - Sharing user information through their profile

After recently changing schools and becoming more familiar with **AMICA**, Érica decides to visit her **own profile**. She notices that she has not changed her description and still has its default version "Olá, o meu nome é Érica e tenho 10 anos". She decides to **edit it** so that other classmates might learn more about her when visiting her profile through **AMICA**.

Although she has made many new friends, she has yet to introduce herself to some of her classmates, such a Nuno. Before approaching Nuno, she opens **AMICA** and **selects his profile**, where she can see his name, age and a brief description about him. Based on his profile, Érica learns that both of them have the same age and, with this information, she decides to engage Nuno, introducing herself and highlighting the fact that they share the same age. Érica and Nuno are now interacting with each other.

Scenario describes how the application can be used to help Érica fulfill the following use cases:

- See own profile (see use case C.1 on page 86);

- Edit profile description (see use case C.2 on page 87);

- See friend's profile (see use case C.3 on page 87).

3.2.2 Scenario 2 - Engaging in cooperative activities

Gabriel arrives early to school and decides to check if Nuno has already arrived as well. Gabriel opens **AMICA** and clicks the "Onde estão os meus amigos?" option. Here he sees a top view image of the school and multiple circles in different places of the image. Gabriel also notices that only the circles near him have an actual picture of a friend of his, the rest have a question mark, indicating that he is not near enough to see who is at that location of the school.

One of the circles whose picture he is able to see on the map is Nuno's, indicating he is able to **see Nuno's location**, so he decides to click it. A pop-up appears displaying a description of Nuno, the same as his profile, and 2 options "Ver perfil" and "Ver colecção de cromos". Gabriel clicks on the "Ver colecção de cromos" option where he is shown a list of stickers, with the same presentation as his own collection, but **Nuno's stickers are shown** instead of his. From this list he notices that one of the circles, related to the friends that can help Nuno obtain the other part of that sticker, has Gabriel's face on it, meaning that he owns the part of the sticker Nuno is missing and Gabriel is missing Nuno's part.

By clicking on the incomplete sticker, a message is displayed asking if Gabriel wants **to invite Nuno** to form a team. Gabriel decides to do so since there is still time before their first class starts. Nuno notices the invite and accepts it. Gabriel and Nuno are now a team and they **accept their challenge**, which is **the "Jogo da Memória"**, a cooperative game where the objective is to flip every card, one per turn, by finding their respective pairs (the other card that has the same image as the one flipped). After finding all pairs, they must answer a question related to their own interests and their teammate's.

Nuno and Gabriel are able to quickly pair every card and answer correctly to the questions "What is your favorite movie?" and "What is your friend's favorite movie?". Both are awarded the sticker half they were missing for that sticker.

Scenario describes how the application can be used to help Gabriel fulfill the following use cases:

- See friend's location on the school yard (see use case C.4 on page 88);

- See friend's sticker collection (see use case C.5 on page 89);

- Inviting a friend through the friend's sticker collection (see use case C.6 on page 90);

- Accept challenge (see use case C.10 on page 93);

- Sticker collecting - "Jogo da Memória" Challenge (see use case C.11 on page 94).

3.2.3 Scenario 3 - Engaging in cooperative activities and being reminded of previously shared interests

A new feature was added to AMICA today, it is a sticker collection. Every student is now able to collect stickers, by joining two halves of the same sticker, until they have completed their collection, and Nuno wants to collect all of them. Nuno decides to use his tablet and open **AMICA** to check this new feature. Once he reaches **AMCIA**'s main page, he notices a button called "Caderneta de Cromos" and decides to click on it. He is **shown a list of his stickers**, each divided in two. From this list, he quickly perceives that he only has half of the sticker number 1, since every other sticker part is blurred except that one.

Along with the list of stickers, additional information regarding how to obtain more sticker parts is also shown. Nuno now knows that he is able to get new sticker halves by logging into **AMICA** once a day but to actually acquire a full sticker he must find another classmate with the other half of the sticker, form a team with him and complete a challenge as a team. Nuno notices that in the middle of each incomplete sticker, between its part 1 and 2, there are circles with the faces of some of his friends, including Gabriel's. Nuno **selects the information icon** and understands that each circle represents a friend which has the other part of the sticker in question and with whom he can form a team.

By clicking on the incomplete sticker, a map of the school, showing the positions of the friends whose faces were on the circles, is displayed. Clicking their position, a message asking if Nuno wants to invite that friend to form a team appears. Nuno **decides to invite Gabriel** so they can form a team and complete the chosen sticker. Since it was possible to invite Gabriel, it means that he is missing the part of the sticker Nuno has.

Gabriel accepts the invite on his device and they are now a team. A page explaining the challenge they will have to face is displayed, alongside two options, one to **accept the challenge** and another to decline. **The challenge is to play "Jogo do Tesouro"**, where

both players, together, must reach a certain location on school, indicated by a treasure icon on the map displayed by **AMICA**. Once they reach the treasure's position, they must answer a question related to their own interests and their friend's. They accept the challenge and successfully reach the spot where the treasure icon was placed and correctly answer the questions "What is your favorite book?" and "What is your friend's favorite book?". Both are awarded the sticker half they were missing for that sticker and are happy their collection is one step closer to being finished.

After completing the challenge, Nuno decides to **see Gabriel's interests**. Nuno knows from previous experience that, by accessing a friend's profile, he can either message them or be reminded of his friend's tastes regarding favorite books, movies, and colors that were shared with him (Nuno). He decides to click on the "Interesses" button and look over his friend's tastes. Here he is shown 3 separate lists, each related to the interests shared by Gabriel with Nuno regarding his (Gabriel's) favorite books, movies and colors. By reading the lists he is reminded that, in the previous challenge they did together, Gabriel had answered "Toy Story" to the question "What is your favorite movie?" and decides to engage in a conversation with Gabriel related with that theme.

Scenario describes how the application can be used to help Nuno fulfill the following use cases:

- See own sticker collection (see use case C.7 on page 91);

- Get additional information regarding the sticker collection (see use case C.8 on page 91);

- Inviting a friend through own sticker collection (see use case C.9 on page 92);

- Accept challenge (see use case C.10 on page 93);

- Sticker collecting - "Jogo do Tesouro" Challenge (see use case C.12 on page 97).

- See friend's interests (see use case C.13 on page 99).

3.3   Use Cases

The scenarios previously depicted, allow us to elaborate use cases based on them, leading us to gather information regarding the requirements related to the system's functionality.

> "*Use cases, on the other hand, are a technique based on exhaustive descriptions of functional requirements of the system, often of a transactional nature, focusing on low-level user action and accompanying system response.*"[41]

The generated use cases, referenced in the scenarios, depict the interaction flow between one or more users and the system, from simple operations, such as viewing user related information (C.1, C.3 and C.7, on pages 86, 87 and 91 respectively) to engaging and completing cooperative activities (C.11 and C.12, on pages 94 and 97 respectively).

3.4   Requirements

Having defined personas, scenarios, and use cases, we can now derive the main requirements that allow the system to behave as described [41].

3.4.1 Functional Requirements

Functional requirements should describe how the system must behave, as well as its features and functions. The functional requirements derived were:

General Requirements:

The application should:

- Identify each user and his relation with other users;

- Ask the users permission to access their device's location;

- Have access to a collection of images representing the stickers;

Requirements regarding user interaction with the system:

The application should allow users to:

- See each others profile, including their own (evidenced on use cases C.1 and C.3, on pages 86 and 87 respectively);

- Edit their own profile (evidenced on use case C.2 on page 87);

- See their friend's location on the school, as well as their own (evidenced on use cases C.4 on page 88);

- See each others sticker collection, including their own (evidenced on use cases C.7 and C.5, on page 91 and 89 respectively);

- See which friends can help him acquire missing sticker parts (evidenced on use case C.7 and C.5, on page 91 and 89 respectively);

- Invite other users to form a team (evidenced on use cases C.6 and C.9, on pages 90 and 92 respectively);

- Undergo and complete challenges as a team (evidenced on use cases C.6, C.9, C.10, C.11 and C.12, on pages 90, 92, 93, 94 and 97 respectively);

- Answer questions related to their interests (evidenced on use cases C.6, C.9 and C.13, on pages 90, 92 and 99 respectively);

- See each others interests (evidenced on use case C.13 on page 99);

3.4.2 Non-Functional Requirements

Non-functional requirements should define the system behavior and general characteristics that affect the user experience. The non-functional requirements derived are displayed below. The application should:

- Be developed for tablet devices, supporting both Android and IOS devices;

- Require user credentials before interacting with it;

- Request permission to access the user's location;

- Support the Portuguese language.

Chapter 4

Development of the Proof of Concept

One of the main goals of this dissertation is to emphasize technology's role in the inclusion of people belonging to different audiences, in the same group, making new contributions to the line of investigation it is inserted in. Regarding inclusion, we have established the ability to communicate as an important stepping stone for this process to be successful, therefore, to help a user communicate is to help him feel included.

Research work and development towards that goal will be represented through the addition of new features to an already existing application, **AMICA** and as a result, a big part of the underlying architecture as well as the technologies that support such features, are shared by both **AMICA** and these proof of concept. Such features were designed to complement **AMICA**, reshaping it to become, as mentioned in section 2.7, "*An application capable of confronting its users with actual social interactions, to assist in their process of feeling included among other audiences, by following a validated curriculum which defines the bases on how such interactions should occur*".

Following the requirements derived previously, this chapter will focus on the development process of the proof of concept, the technologies used, its architecture, and the multiple design iterations it underwent, from its prototyping stages to the final version. In that regard, our approach starts by creating high fidelity mockups, used as the main topic of the discussions held with multiple stakeholders, followed by a functional prototype evaluated by end-users.

4.1 Architecture

Since the resulting features were to be introduced in an already existing application, **AMICA**, they were developed taking into consideration the already underlying architecture, so as to not abruptly change its core, allowing the new version of **AMICA** to retain its previous features.
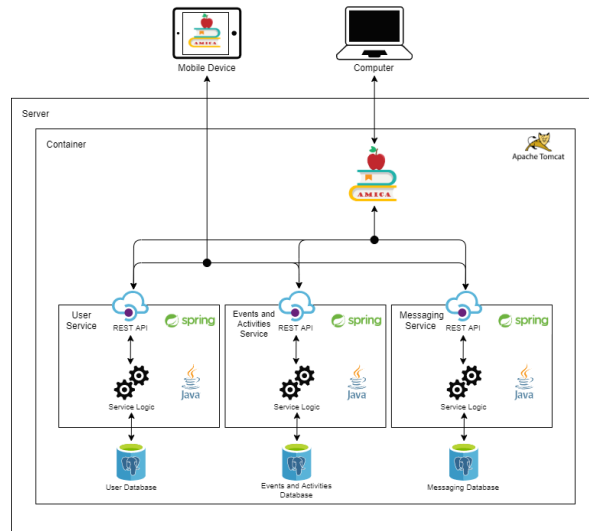
(a) Original **AMICA** architecture
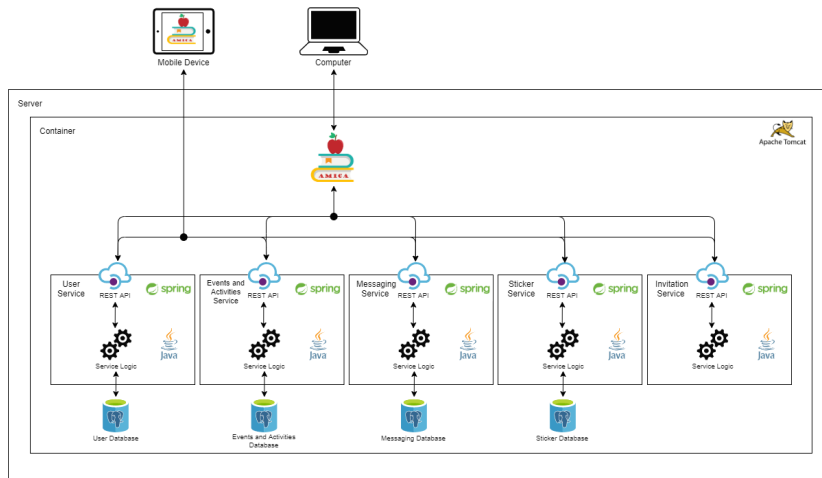
(b) **AMICA** architecture after the introduction of the new features, adding 2 new services, the Sticker service and the Invitation service

Figure 4.1: Architectural changes considering previous approaches. For the current work, the adopted architecture evolved from the one already present in **AMICA** (4.1a), with the addition of two new services, Sticker and Invitation, that follow the structure of the previous ones (4.1b)
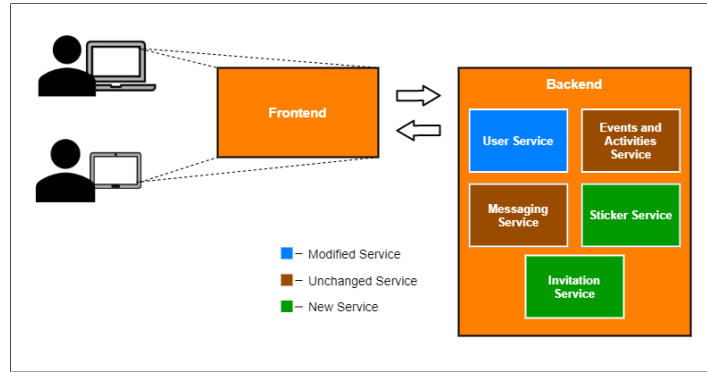
Figure 4.2: Simplified view of the architecture displaying the interaction between the device, frontend, and backend, in a simplistic manner, exhibiting which services, regarding the original architecture (4.1a), were changed, unchanged, and added

AMICA was developed to allow users to access it through multiple platforms, using Apache Cordova and standardized web technologies, namely HTML, JavaScript, and CSS, to make it possible.

Users are able to interact with the application on their devices by accessing the website on their desired browser. Furthermore, it is also possible to deploy it in other versions, such as an Android version for example. The only difference between both versions is that the latter was compiled by Apache Cordova into an **A**ndroid **P**ack**age** file (**APK**) to be run by Android devices. Android runs the application through a web view, thereby, simulating a native application to the end-user.

Apart from the application itself, two services that support both the original and the newly added features in **AMICA**, were also developed. Each service was developed with Spring Boot and Java, and the majority of them communicate with an external PostgreSQL database. This database differs depending on the service.

The web version, as well as all the services and databases, will be deployed on a server running in the schools that adopt the system, services are then run on Tomcat. That way, except when accessing **AMICA** through a mobile device running the mobile version of the application, all logic is run on the server, taking workload away from the user's device. Communication with the school server is then absolutely necessary otherwise the application would not be able to run. Some features are also dependent on an active internet connection, such as the "Onde estão os meus amigos?".

4.2   Support Technologies

As suggested by the changes made to **AMICA**'s original architecture, the majority of the technologies that supported the development of the new features are the same as the ones used for the creation and integration of the already existing ones in **AMICA**.

Spring Boot

Built on top of the Spring framework, Spring Boot is used to build stand-alone and production-ready spring applications, in a simple and quick fashion. By allowing developers to automatically configure their Spring application or changing the configuration based on

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the dependencies they list, as well as removing the need for the application to be deployed on a web server, Spring Boot lets them focus solely on application development.

Web Containers

A web container is the component of a web server that interacts with Java servlets. It is responsible for managing the life cycle of such servlets, mapping a URL to a particular servlet ensuring, at the same time, that the requester has relevant access-rights.

Used to support applications that do not require a full Java EE server, Apache Tomcat is an open-source Java servlet container that provides an HTTP web server environment in which Java code can run. Although it does not provide the full feature set from the Java EE, as previously mentioned, the features it does provide are enough for many applications, such as Spring applications.

Database Engine

The underlying component that a **d**ata**b**ase **m**anagement **s**ystem (**DBMS**) uses to allow the execution of data management operations is called a database engine. The database engine used in **AMICA**'s development was PostgreSQl.

PostgreSQl is an open-source object-relational database system that uses and extends the SQL language. It is supported by multiple platforms such as Windows, Linux, and macOS, featuring transactions with **A**tomicity, **C**onsistency, **I**solation, **D**urability (**ACID**) properties and powerful add-ons such as PostGIS, a spatial database extender which adds support for geographic objects allowing location queries to be run in SQL.

Apache Cordova

Apache Cordova is an open-source mobile development framework that allows developers to build web applications through the usage of standard web technologies, such as HTML5, CSS3, and JavaScript, for cross-platform development. Applications are inserted and executed within wrappers appropriate to each platform, accessing each device's capabilities through a set of APIs supplied by Cordova.

Core JavaScript Libraries

Leaflet

Leaflet is a JavaScript open-source library used to build web mapping applications. While Leaflet has a core set of features, easily allowing a developer to display and interact with web maps, third-party plugins can also be used to further extend its functionality, from overlay animations to geoprocessing. Leaflet is also supported across all major desktop and mobile platforms.

Sockjs

SockJS is a browser JavaScript library that provides a WebSocket-like object. Through SockJs we are able to create a low latency, full-duplex, cross-domain communication channel between the browser and the webserver.

Combining the creation of SockJs clients with the WebSocket capabilities of Spring, enabling WebSocket message handling, backed by a message broker, we can establish communication between multiple devices, allowing them to exchange information.

4.3   Multi-Device Communication

In order for users to undergo cooperative challenges, communication between both user devices had to be established. A service to enable both devices to communicate and keep them both synchronized with each other while undergoing said challenges was also developed.

Before moving onto further details, it is important to define **WebSocket** and **STOMP**.

WebSocket

The WebSocket protocol enables interaction between a web browser (or other client application) and a web server while making the process of real-time data transfer from and to the server, simpler. According to [47]:

> "*The protocol consists of an opening handshake followed by basic message framing, layered over TCP. The goal of this technology is to provide a mechanism for browser-based applications that need two-way communication with servers that does not rely on opening multiple HTTP connections (e.g., using XMLHttpRequest or <iframe>s and long polling).*".

Therefore, WebSockets allow the creation of a persistent connection between the client and the server, where a two-way ongoing conversation can take place.

STOMP

Simple Text Orientated Messaging Protocol (**STOMP**) is a messaging protocol that provides an interoperable wire format that allows **STOMP** clients to communicate with any STOMP message broker, providing widespread messaging interoperability among many languages, platforms and brokers.

The mentioned service is essentially a server that allows multiple clients to connect to it, enabling them to exchange information between them by sending messages and subscribing to different queues. This communication is made through **WebSockets**, having **STOMP** act as a subprotocol operating on top of it.

When a user logs into **AMICA**, the client connects to the server and proceeds to subscribe to a queue identified by the own user's id. By doing so, messages can be sent to each specific user. Such messages, in order to be exchanged, must follow pre-determined structures that may vary depending on the "Type" field of the respective message. It is worth noting that the "Timestamp" field is inserted by the server and not by the original sender. The basic structure of every message is:

```
Basic Message Model:
    SenderId
    RecipientId
    Type
    Timestamp
```

When a user invites another to form a team with, for example, a message is sent to the invited device, after being processed by the server, with the type "Request". After the target device receives this type of message, it displays a popup on the invited user's device with the inviter's avatar, the part of the sticker to be acquired and the possible answers to the invite ("Accept" or "Decline"). Depending on the type of message received, different actions can be triggered in one or both devices.

```
Invitation Message Model:
    SenderId
    RecipientId
    Type
    TimeStamp
    SenderName
    SenderAvatar
    Reward
    ChallengeId
    QuestionId
    Question1
    Question2
    Category
```

It is important to reinforce that these are models, therefore they can be reused when sending different types of messages where the same field types that make up the model are required. For example, when answering the first question at the end of the challenge "Jogo do Tesouro" or "Jogo da Memória", a message is sent to the teammate's device, containing the given answer. Here, the model used is:

```
Answer Message Model:
    SenderId
    RecipientId
    Type
    Answer
    TimeStamp
```

The "Answer" field, in this scenario, contains the answer given by the user's but, in other contexts, such as while undergoing the "Jogo da Memória" challenge, that same model is used, although the contents of the fields "Type" and "Answer" are different. In this case, the field

"Type" has "FirstFlip" as its value and the "Answer" field is related to the card that was flipped by the user that sent the message, and not to an actual answer given by him.

A more detailed description of the different types of messages, that incorporate these models, is presented in appendix D.

4.4   Development Timeline

The development process of the proof of concept was divided into multiple phases:

- **Phase 1 - Design of high fidelity mockups**: At the beginning of the development process, we felt the need to propose a first approach to the requirements obtained (section 3.4), through the creation of a first set of mockups representing the features to be developed. The usage of a tool such as AdobeXD, greatly simplified this process, mainly because it not only provided a simple interface with a generalized view of every mockup, but it also allowed the creation of flows between them, providing eventual testers with a sequence of mockups that were able to mirror future interaction flows with the features to be developed;

- **Phase 2 - Evaluation of the first version of the developed mockups**: After creating the mockups and defining the flows between them, we decided to evaluate them, first with a set of computer science students with the purpose of finding issues regarding the elements displayed in the interface and flow, and afterward, with a set of speech therapists, through separate interviews and cognitive walkthroughs, to understand if the features to be developed would be seen as fun and interesting by the children and if the interface was friendly enough for them;

- **Phase 3 - Revised Mockups**: With feedback related to the first set of mockups gathered, changes were made to them, reflecting the collected information;

- **Phase 4 - Evaluation of the revised version of the developed mockups**: Just like previously, evaluations were made to the revised versions of the mockups, having the computer science students assess the mockups through a heuristic evaluation and a speech therapist undergo cognitive walkthroughs;

- **Phase 5 - Development of the proof of concept**: With the final version of the mockups ready, we started to develop and implement the actual proof of concept. Here, certain changes and improvements, that were not specified in the previous mockups, were made to better incorporate the feedback from phases 2 and 4;

- **Phase 6 - Evaluation of the developed proof of concept**: Following the full development of the proof of concept, we arranged a meeting with one of the therapists to validate the new additions made to the proof of concept and understand if it was ready to be tested by actual end-users;

- **Phase 7 - End user evaluation**: Upon receiving confirmation that the proof of concept was ready, a session with actual end-users occurred, allowing us to understand how it was perceived by them and how it could improve.

4.5   High Fidelity Mockup

As previously mentioned, in section 2.6, a **UCD** approach was used to create and evolve **AMICA**. Being an iterative design process, where the users and their needs are the main focus of every phase of the process, **AMICA** underwent multiple iterations to make sure users found the system useful and their needs were satisfied.

We started by redesigning **AMICA**'s home page. After doing so, we moved onto prototyping the features to be introduced, derived from the requirements (section 3.4), namely, the "Caderneta de Cromos" and "Onde estão os meus amigos?". A first set of challenges were also modeled to complement the "Caderneta de Cromos" feature, as well as a user profile.

4.5.1   Overall Features

Focusing on technology as a cognitive prosthetic, through the exploration of methods to promote communication and integration for all, the features to be introduced aim to develop their user's social skills based on the "Social Compass" [3], a validated curriculum aimed to help children with autism disorder achieve social success, through a series of cooperative activities which reward every user involved. According to the Social Compass and related studies ([12], [13]), for a simple social interaction to occur successfully, minimal social skills, such as eye contact, space, and proximity, interaction initiation, asking questions, sharing of interests and interaction termination, are required. Therefore, the features that resulted from the exploratory work, the "Caderneta de Cromos" and "Onde estão os meus amigos?", will focus on the potential improvement of these social skills, leading the user to undergo social interactions, employing said social skills, without being explicitly told to do so.

Modifications to an already existing system, through the introduction of new features, for example, may lead to changes related to the appearance, and interface of an application, the position of each element, their colors and their contents, since they all contribute, not only to transmit a specific feeling to the user but can also help the user complete application-related flows, acting as visual guides to initiate and finalize such flows. Developers of any application, especially one designed mostly for children, have to bear in mind that its users may be interacting with an application or even a system for the very first time, meaning that the application interface must be intuitive enough to clearly transmit to the user what is the purpose of each element and what are the results of interacting with it.

The early design iterations of **AMICA**'s evolution, consisted of exploring what was considered to be the latest state of **AMICA** at the time, and developing mockups for every new feature to be added. All mockups were developed using Adobe XD. It is worth mentioning that since the work revolving around this dissertation is here represented as an evolution of **AMICA**, its original interface was kept, so that any current users may see this evolution as a direct upgrade to **AMICA**, without having to re-learn its interface.

Upon first interacting with **AMICA**, we noticed that, although every element had an image clearly depicting its purpose, the colors seemed to give a neutral feel to the application, not conveying any specific emotion to the user. Since this is an application for children, a change to the color scheme was made with the goal of delivering a more pleasant feel while using **AMICA**.
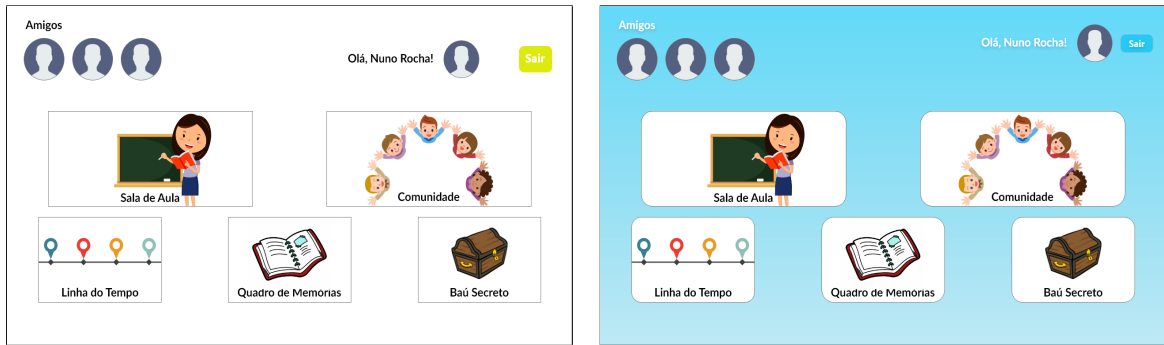
(a) Original "Inicio" mockup page

(b) "Inicio" mockup page after changing the color scheme, letter fonts and the style of the elements

Figure 4.3: Comparison between **AMICA**'s orignal "Inicio" mockup page (4.3a) and its revised version (4.3b), displaying changes to the overall color scheme, letter fonts and the style of the elements

The color scheme, letter fonts, and the style of the elements represented in 4.3b were applied to all original pages belonging to **AMICA**. After making the desired changes to the original state of **AMICA**, modifications to the interface related to the new features to be inserted were followed.

4.5.2 "Caderneta de Cromos"

In order to have users socially interacting with each other, without directly instructing them to do so, we have decided to include a motivation factor, one that encourages social interaction in a natural manner.

The "Caderneta de Cromos" feature was created with this purpose, to motivate its users to interact with each other through a reward system. Although the association between rewards and motivation is a matter of controversy, existing arguments both supporting and against motivation being driven by an external reward (extrinsic motivation) instead of enjoyment and personal interest (intrinsic motivation) [48], we feel that, since we will be using a digital system to the assist the user, and according to [48], "*Digital technology has been shown to be an ideal medium for providing extrinsic rewards*", a system that rewards the user with something related to his own personal interests is the appropriate solution. Since some users may want to initiate interaction with the sole purpose of achieving a certain goal, such users might be motivated to acquire only the reward. Although this may be seen as going against the main purpose of this feature, in order to acquire that reward they will still have to make an effort to interact with others, otherwise, they will not obtain the reward. It is worth mentioning that completing a sticker collection may not motivate every user the same, but we want to demonstrate that, if an appropriate reward system is employed, regardless of the form it takes, it is possible to assist the user to employ different social skills in different social scenarios and, if properly done, may even improve those same skills.

Every user starts with a varied set of incomplete stickers and the only way to complete them is by forming a team with a friend and successfully complete a challenge. Only friends that possess the missing sticker part the user is looking for may be invited. By doing so we encourage the user to interact with different people each time he selects a new sticker to complete. These challenges have been created to drive the user to indirectly employ certain

social skills, potentially improving them. These social skills, as emphasized further on in the document, make up a simple social interaction.
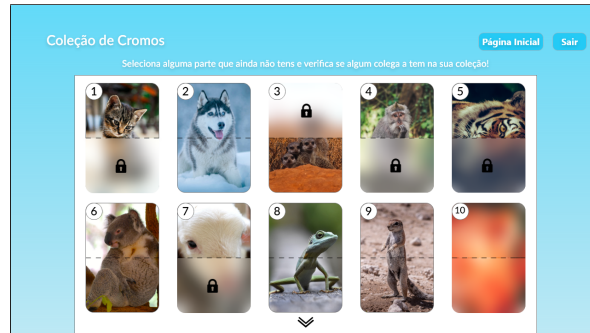
Figure 4.4: "Caderneta de Cromos" mockup page, displaying the user's sticker collection

In this sticker collection, each sticker is composed of two individual parts, as well as an identifier.

(a) Sticker structure   (b) Sticker structure with identifier
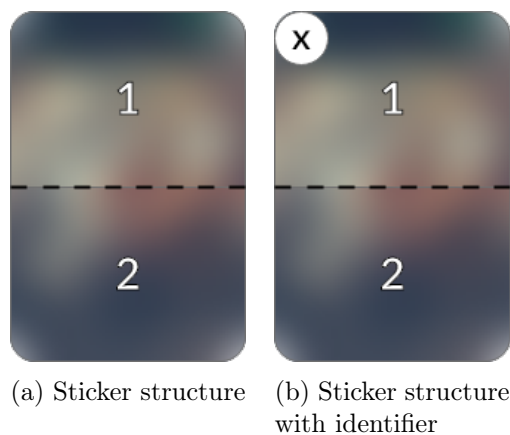
Figure 4.5: Sticker structure with (4.5b) and without (4.5a) identifier, where 1 and 2 represent the first and second part of the sticker, respectively, and x the identifier

The possible states a sticker can have on my collection are as follows:

- Missing - I am missing both sticker parts;

- Incomplete - I am missing a sticker part;

- Complete - I have acquired both parts of the sticker;

(a) Missing sticker   (b) Incomplete sticker   (c) Complete sticker

Figure 4.6: Initial mockup of the visual feedback for missing (4.6a), incomplete (4.6b) and complete (4.6c) states of a sticker, on the user's own collection

Because a user is able to see his own collection as well as his friends', we decided to create a similar interface composed with recognizable elements in both pages, intended to enable the user to interpret both sticker collections the same way. This was particularly challenging since each sticker has a state related to its completeness and they must be easily interpreted while accessing his own sticker collection and his friends' collections.

While viewing a friend's sticker collection, the user must be able to make the following distinctions:

- Both me and my friend have the sticker part;

- Only the friend has the sticker part;

- None of us has the sticker part;

- Friend has a sticker part that complements one of mine.

Our first approach, when designing the friend's sticker collection page, was focused on emphasizing those distinctions.
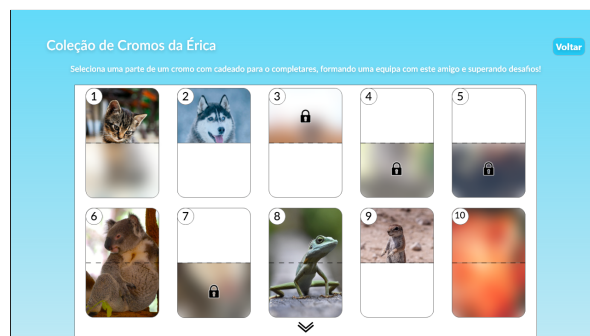
Figure 4.7: Friend's sticker collection view mockup page

(a) Neither me or my friend have the sticker parts

(b) Both me and my friend have the sticker parts

(c) Only the friend has the sticker part

(d) Friend has a sticker part that complements one of mine
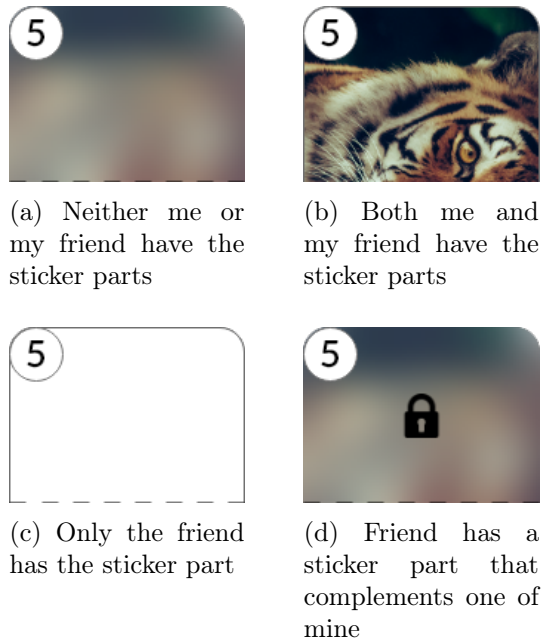
Figure 4.8: Initial mockup of the visual feedback for sticker parts neither me or my friend have (4.8a), both me and my friend have (4.8b), only the friend has (4.8c) and sticker parts my friend has that complement my own (4.8d) states of a sticker, on the friend's sticker collection

Unfortunately, not only did we create an extremely complex interface, as evidenced during the first mockup evaluation, this approach also went against what was previously said about delivering a similar experience to the same user while he interacts with his own and other user's collections.

For a user to complete a sticker, he must first possess one of its parts, invite a friend that owns the missing counterpart to form a team with him and, finally, surpass the proposed challenge. So as to aid the user during this process, we designed a page with a map, similar to the one presented in the "Onde estão os meus amigos?" feature, to tell the user where those friends, that can help him complete each sticker, are located inside the school perimeter.

(a) Map view of friends that can help the user complete the selected sticker mockup page

(b) Invite user to form a team popup

Figure 4.9: Team invitation mockup page, where the user that selected a sticker to complete, is able to view the location of users that have the missing sticker part (4.9a) and can help him complete it by inviting them to form a team (4.9b)

For the user to better identify his own position on the map, a green circle was placed around his avatar.

It is important to note that a friend can only be invited if both the user and the friend are close to each other (up to 6 meters apart). Furthermore, a user can only be invited if he is not classified as "busy" by the application. The system takes into account what the user is currently doing on the application, such as viewing another person's sticker collection or undergoing a challenge, and assigns them a "busy" or "not busy" status.
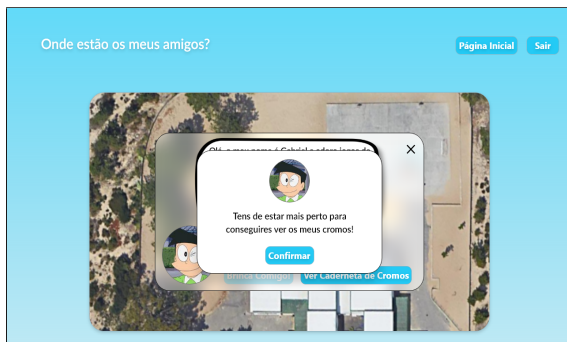
(a) Friend is too far to be invited

(b) Friend is busy and cannot accept the invitation

Figure 4.10: When attempting to invite a friend to form a team, the user may not be allowed to do so when the friend to be invited is not in range (4.10a) or considered "busy" by the application (4.10b)

When successfully inviting a friend to form a team with, the invited user will have a popup appear on their device while using **AMICA**.

Figure 4.11: Team invitation request popup

By accepting the invite, both team members are shown the challenge randomly selected by the application and its instructions.
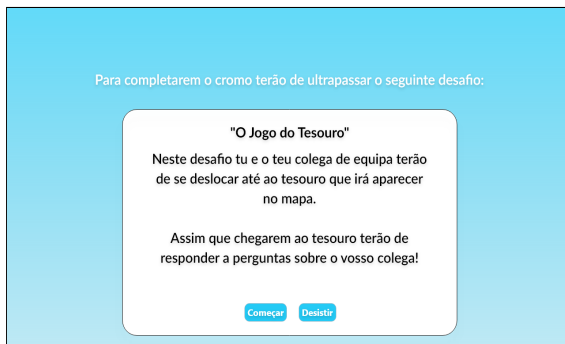
(a) "Jogo do Tesouro" instruction mockup page
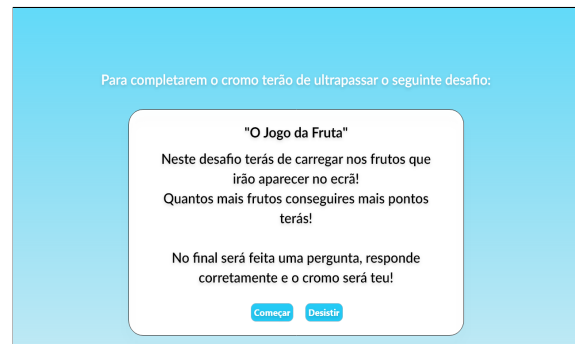
(b) "Jogo da Fruta" instruction mockup page
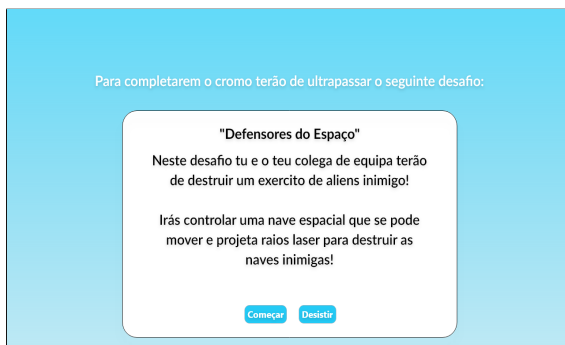
(c) "Defensores do Espaço" instruction mockup page
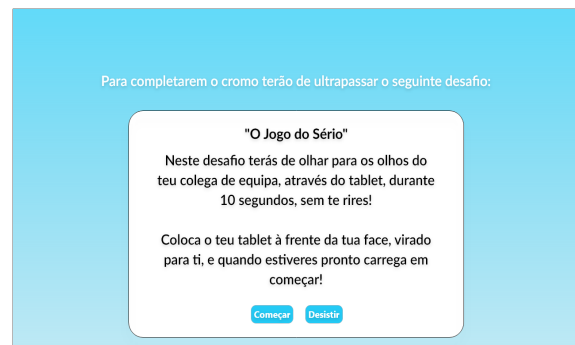
(d) "Jogo do Sério" instruction mockup page

Figure 4.12: Challenges' instruction mockup pages, each page has an introduction to the challenge as well as instructions on how to play it

Team members are given the possibility to quit or undergo the challenge, if one of them decides to quit, both users are redirected to the home page and the team is disbanded.

"Caderneta de Cromos" Challenges

To acquire missing sticker parts, challenges have to be successfully completed with a friend. These challenges are meant to be cooperative and are intended to have the team that is undergoing said challenge, to make use of certain social skills. Five challenges have been created in total and two of them have been fully implemented in **AMICA**. Initially, mockups were designed to four of the challenges.

Challenge: "*Jogo do Tesouro*"

"Jogo do Tesouro" is a challenge which objective is to team up with a friend and reach the location of the treasure chest displayed on the map. Once near the treasure chest, each one must ask and answer a question related to each other in order to unlock the chest and complete the challenge.
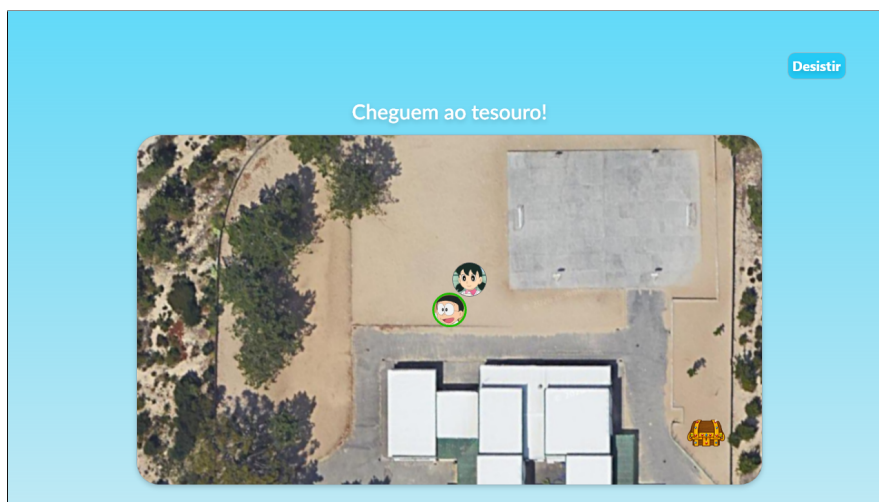
Figure 4.13: "Jogo do Tesouro" mockup page

The instructions to play and complete the challenge are depicted below.

Instructions

Player 1 and player 2 are displayed the location of the treasure chest on the school map and they must reach its location. Once near the chest, the system will display a question to both player 1 and player 2, on their respective devices, regarding their own interests (the question is the same for both). After answering the first question, a second one appears regarding the other player's answer to the previous question. By correctly answering the second question the challenge is complete.

Examples of questions are:

- "What is your favorite color?" and "What is your teammate's favorite color?";

- "What is your favorite superhero?" and "What is your teammate's favorite superhero?";

- "What is your favorite movie?" and "What is your teammate's favorite movie?";

- "What is your favorite book?" and "What is your teammate's favorite book?".

Social Skills in Use

This challenge makes use of the following social skills:

- Space and proximity;

- Asking questions;

- Sharing interests.

Challenge: "*Jogo da Fruta*"

"Jogo da Fruta" is a challenge which objective is to team up with a friend and acquire the highest amount of points possible by tapping the fruits falling down on the device's display for a set amount of time. In the end, a mathematical question must be correctly answered.

Figure 4.14: "Jogo da Fruta" mockup page

The instructions to play and complete the challenge are depicted below.

Instructions

Player 1 and player 2 are displayed separate instances of the game on their device. In each instance, fruit starts falling down and they must tap on it to get points. If the amount of points acquired by the players individually does not exceed a certain threshold both players lose the challenge. If it exceeds, then a mathematical question appears such as:

- "How much points did you and your friend obtain together?";

- "How much points did you and your friend obtain together if the score was subtracted by 100?";

- "If you had gotten minus 50 points than you did, how many points would you and your friend obtain together?".

- "If you multiply the number of points you and your friend obtained together by 2 how many points would you both get?"

- "If you divide the number of points you and your friend obtained together by 2 how many points would you both get?"

Once the question is correctly answered, the challenge is over.

Social Skills in Use

This challenge makes use of the following social skills:

- Space and proximity;

- Asking questions.

Challenge: "*Defensores do Espaço*"

"Defensores do Espaço" is a challenge which objective is to team up with a friend and defeat an enemy alien fleet by using spaceships that can move and fire beams by tapping the device's screen.
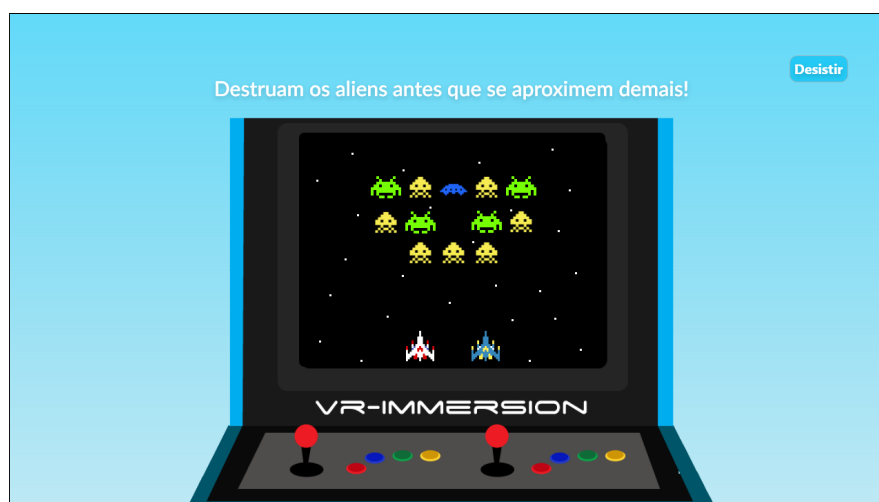
Figure 4.15: "Defensores do Espaço" mockup page

The instructions to play and complete the challenge are depicted below.

Instructions

Player 1 and player 2 are displayed the same instance of the game on their tablet. Here they will control their own spaceship, which can move sideways and is able to fire laser beams by tapping on the device's display, to fight an enemy alien fleet constituted of multiple alien spaceships which descend the screen as time goes on, becoming faster over time. If the players are able to destroy every single alien spaceship before they get to the player's spaceships they win and successfully complete the challenge. If not, they must try again.

Social Skills in Use

This challenge makes use of the following social skills:

- Space and proximity;

Challenge: "*Jogo do Sério*"

"Jogo do Sério" is a challenge which objective is to look to your teammates eyes, through the device's display, without laughing for a set amount amount of time (10 seconds).
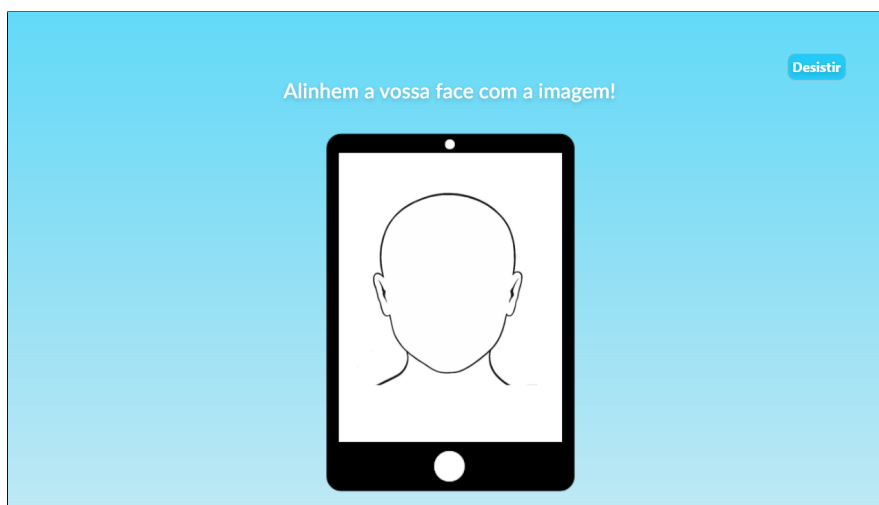
Figure 4.16: "Jogo do Sério" mockup page

The instructions to play and complete the challenge are depicted below.

Instructions

Player 1 and player 2 must position their face according to the image displayed on their device. Once the system checks the position of both players faces, the camera on both tablet start streaming their faces and the game begins. On the player 1 device, a live stream of the player 2 device camera is displayed and the opposite happens in the player 2 device. If during the 10 second timer, the system stops detecting a face or tracks the player's gaze on another location other than the other player's eyes, the challenge fails and they may try again until they successfully complete it.

Social Skills in Use

This challenge makes use of the following social skills:

- Eye contact;

- Space and proximity.

As it can be seen, every challenge emphasizes cooperation between the members of the team trying to surpass it. Although some challenges make use of the same social skills, the goal of the challenge and the steps to complete them differ from each other. Furthermore, challenges such as the "Jogo da Fruta" and the "Defensores do Espaço" incorporate questions related to education, potentially acting as interesting educational approaches. Every challenge was considered to make use of the space and proximity social skill because both users must be close to each other to invite one another.

From the described challenges, the "Jogo do Tesouro" was one of the implemented challenges in **AMICA**. The other one was the "Jogo da Memória" challenge, which will be described later on since it was modeled and implemented during the second iteration. Both these challenges were selected to be implemented taking into consideration the interviews and feedback given by the therapists, the number of social skills used to complete them and the need for an indoor and an outdoor challenge, in case the evaluation session with end-users had to occur under unforeseen circumstances.

4.5.3 "Onde estão os meus amigos"

The "Onde estão os meus amigos" feature was designed with the intent of clearly showing where each of the user's friends is located inside the school perimeter, helping users find their friends while in school, also allowing the user to access his friends' sticker collections from this feature.

(a) "Onde estão os meus amigos?" mockup page

(b) "Onde estão os meus amigos?" avatar interaction

Figure 4.17: "Onde estão os meus amigos?" mockup page (4.17a), where the avatar's of the user's colleagues are shown at their actual position inside the school perimeter and the avatar interaction mockup page (4.17b)

The button "Brinca Comigo" was initially designed to allow users to access a feature aimed at helping them practice their social skills, given a fictional social scenario involving

the selected friend. Unfortunately, this feature was not implemented, but the initial mockups were prepared for its introduction.

4.5.4 User Profiles

Although not a major feature as the ones previously mentioned, a user profile page was modeled so that users may share their interests publicly, making different users know more about each other before introducing themselves to one another. Further ahead, during the actual development process, a user profile can be considered a repository for the information shared with that specific user, acting as a possible reminder of a friend's interests.
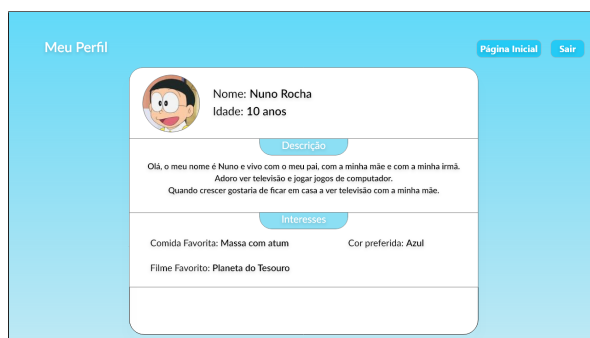
Figure 4.18: User's own profile mockup page, displaying a short description about him and his favorite tastes related to food, color and movies

After designing the mockups of the mentioned features, it was necessary to reiterate over the mockup of the "Inicio" page (4.3b), in order to reflect the addition of those features.

Figure 4.19: Final "Inicio" page mockup based on its initial design (4.3b)

4.5.5 Evaluations

In order to identify possible struggles a user might encounter when interacting and interpreting the interface displayed by the previous set of mockups, a preview of the interface, composed of sequential flows between the designed mockups, was shared with 5 Computer Science students and 2 speech therapists.

Brainstorm with Computer Science Students

After they analyzed the preview, an informal discussion, one to one, was held with each student individually. Every tester considered the "Inicio", "Perfil" and "Onde estão os meus amigos?" pages as intuitive, enabling them to perceive the purpose of each page and what they were able to do in them. Suggestions regarding the representation of friends in the "Inicio" page were given, saying that the number of friend avatars to be shown should be limited so as to not display too much information that can easily be present in other, more appropriate, pages. Another suggestion given by a tester was the addition of a button to edit the user's profile if he ends up having permission to do so.

When evaluating the "Caderneta de Cromos" mockup page, where a user sees his own collection, the interface elements were intuitive enough to understand the acquired and missing states of each part of a sticker and, consequently, the complete and incomplete state of each sticker. However, four of the five testers recognized that allowing users to see sticker collections, other than their own, was a complex task since a user has to be able to correctly interpret another user's collection just as he would interpret his own, while at the same time recognizing which stickers, or parts, he already obtained that the owner of the sticker collection he is observing is missing, and the other way around.

Multiple suggestions were given to make the interpretative process simpler, to give a more clear notion to the user about each sticker state and the respective parts, in relation to the collection being seen and his own, such as literally presenting the state of a sticker part, by associating a color to the border of each sticker part according to its state, for example. Those solutions, although helpful, still forced users to recall an unnecessary amount of information in order to clearly perceive the visual feedback they were given on this page.

Regarding the "Onde estão os meus amigos?" feature, two testers suggested that the possibility to check the location of every friend, even if only inside the school, could be considered as violating their privacy. A possible solution to this problem was suggested by a tester, instead of clearly showing where every specific user is, only users at a certain range of the user are clearly shown, the location of the rest of the users are still shown but not who is positioned there.

Evaluation by Professionals

Because it was also crucial to acquire the feedback of professionals that work closely with children, including children with **ASD**, since they are familiar with different games and applications designed specifically for them (the children), a structured interview and mockup evaluation were conducted with two therapists, individually.

When shown every challenge, the therapists emphasized the necessity of cooperation to overcome them as an important characteristic, since that helping each other accomplish a common goal may potentially make them want to interact with one another again. Regarding each particular challenge, both therapists agreed that the "Jogo do Tesouro" challenge, was the most interesting one since it makes both teammates share personal interests with one another, possibly leading to the formation of friendships. One of the therapists also pointed out that in the challenge "Jogo do Sério", although both users can in fact look at each other«s eyes, this eye contact still occurs indirectly, with technology as a mediator. Finally, when asked what types of games are usually enjoyed by the children they assist, the memory game was heavily highlighted.

In regards to the mockup evaluation, both therapists also tested the shared mockup flows so that feedback from users accustomed to interfaces designed for children, could be acquired. This evaluation was made using the cognitive walkthrough method, mentioned in section 2.6, and the results are shown in F on pages 116 and 117. For these cognitive walkthroughs, a set of predetermined tasks, 13 in total, were given to each therapist, after exploring the mockups. These tasks requested the testers to undergo certain modeled application flows, such as acquiring new sticker parts and to report what they perceived regarding certain elements of the interface, such as the multiple states present in a friend's sticker collection page. After completing each task, the therapists were asked to access how difficult it was to execute, ranging from 1(very easy) to 4(very hard).

As evidenced before, the major problem was the interface displayed when viewing a friend's sticker collection. All tasks related to identifying the state of each sticker part were given a 4 by both therapists, mentioning that there were too many states to be identified by the user. The rest of the tasks were given difficulties of 1 and 2. One of the therapists also mentioned that, when viewing another friend's profile, the ability to see that friend's personal interests would be more interesting if, in order to see them, interactions between each other had to occur first.

4.6   Revised High Fidelity Mockup

4.6.1   Development

The collected feedback gathered during the previous evaluation session, resulted in changes to the original mockups, especially to the friend's sticker collection page.

"Caderneta de Cromos"

Regarding the sticker collection pages, when viewing one's own sticker collection, the avatar of friends that can help the user acquire missing sticker parts are now displayed in the middle of the respective stickers, avoiding additional actions to access this information. This modification replaces the need for the lock icon, creating a more intuitive experience for the user.
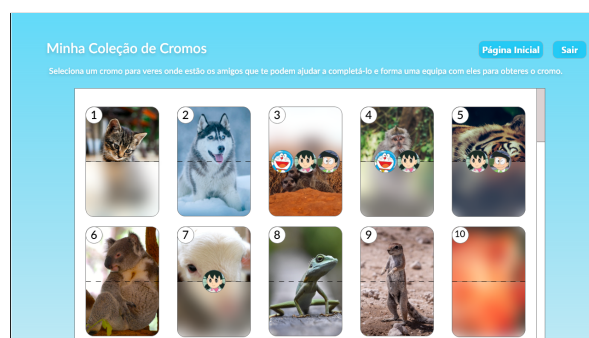
Figure 4.20: "Caderneta de Cromos" final page mockup based on the previous mockup (4.4)
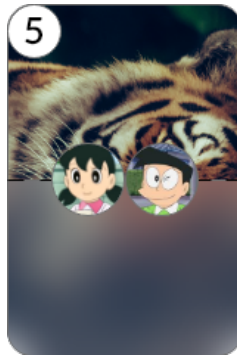
Figure 4.21: Final sticker view on my collection based on the previous mockups (4.5)

As previously mentioned, the friend's sticker collection page suffered major changes.

(a) Friend sticker collection page mockup, first alternative

(b) Friend sticker collection page mockup, second alternative

(c) Friend sticker collection page mockup, third alternative

(d) Friend sticker collection page mockup fourth alternative

Figure 4.22: Friend sticker collection page mockup alternatives

After undergoing through multiple alternatives, we finally reached a simpler and more intuitive version of the friend's sticker collection page.
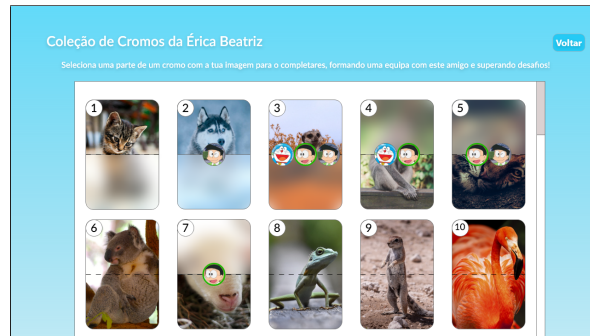
Figure 4.23: Friend sticker collection final page mockup based on previous iterations (4.7 and 4.22)

This version replicates the same exact elements as the ones presented in the user's own sticker collection page, displaying a friend's sticker collection the same way that friend sees his own, with the exception that, when viewing another person's sticker collection, if the user possesses a sticker part which the friend is missing, his own avatar will appear (surrounded by a green border just like in the "Onde estão os meus amigos?" feature). Although this decision eliminates part of the mystery surrounding the contents of missing sticker parts, which was the main reason why there was such a multitude of states in the first place, we believe that it favors a much simpler and friendlier interface.

(a) Final sticker mockup view on my collection

(b) Final sticker mockup view on friend's collection
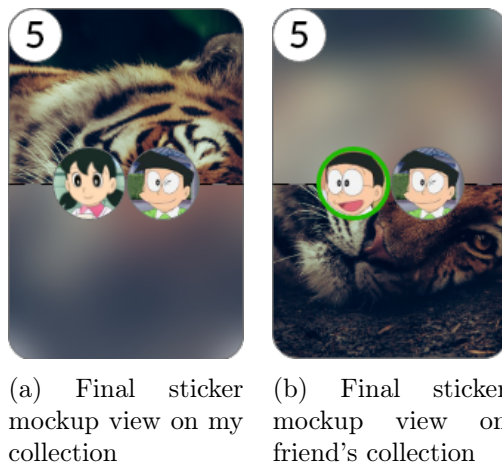
Figure 4.24: Final sticker structure mockup view on the user's own sticker collection (4.24a) and on a friend's sticker collection (4.24b)

User Profile

As suggested in subsection 4.5.5, a button implying the ability to edit a user's own profile was added to the profile page.
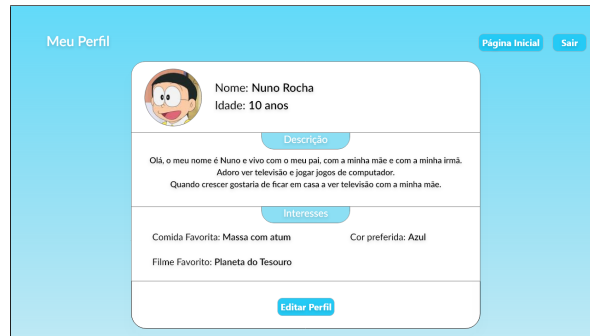
Figure 4.25: User profile final page mockup based on previous versions (4.18)

Taking into consideration the feedback related to the display of a friend's personal interests, a mockup page dedicated only to the view of a friend's profile page was designed.
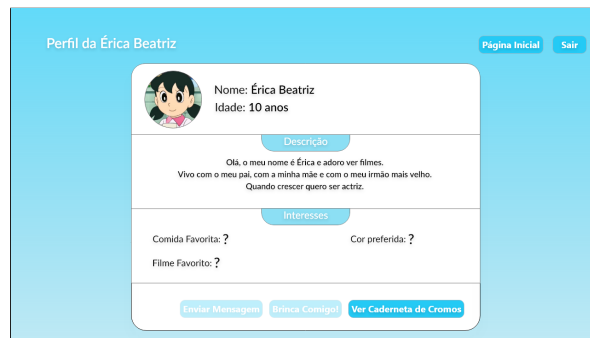
Figure 4.26: Friend's profile page mockup

The idea behind the exclamation marks, suggestion given by one of the therapists in appendix A, is to hide that information from the user viewing the profile until he has surpassed a challenge that involves the sharing of personal interests, such as the "Jogo do Tesouro", with that friend.

4.6.2 First Iteration - Mockup Evaluation

In order to evaluate the changes made in this iteration, an heuristic evaluation 2.6 with four of the previous students was conducted. For this, a preview of the interface, composed of flows between the developed mockups of the system was, once again, shared with the colleagues, as well as a document introducing the goal of the preview and which functionalities were developed. In this document every principle related to the heuristics was also depicted, so that, after interacting with the mockups, problems related to each of the principals could be reported accompanied by their severity level (0-4):

- 0 = I don't agree that this is a usability problem at all;

- 1 = Cosmetic problem only: need not be fixed unless extra time is available on the project;

- 2 = Minor usability problem: fixing this should be given low priority;

- 3 = Major usability problem: important to fix, so should be given high priority;

- 4 = Usability catastrophe: imperative to fix this before the product can be released.

Heuristic	Observation Severity			
	User 1	User 2	User 3	User 4
Visibility of system status	-	-	2	2
Match between system and the real world	-	-	-	-
User control and freedom	-	-	-	3
Consistency and standards	-	-	-	-
Error prevention	-	-	-	-
Recognition rather than recall	-	2	-	-
Flexibility and efficiency of use	1	-	-	2/1/2
Aesthetic and minimalist design	-	-	-	1
Help users recognize, diagnose, and recover from errors	-	-	-	-
Help and documentation	-	-	-	-

Table 4.1: Results of the heuristic evaluation regarding the first mockup iteration considering Nielson's heuristics:
Evaluators found 9 possible violations overall, the one with a higher number of observations being "Flexibility and efficiency of use"

Table 4.1 shows the overall results for the evaluation of the mockups' first iteration adopting Nielsen's heuristics. Overall, the evaluators found 9 possible violations of the respective heuristic. Of note is the violation of heuristics "Flexibility and efficiency of use" and "Visibility of system status" with severity levels ranging from 1 to 2. From the violations referred by the evaluators on those heuristics, there were two observations that should be emphasized.

Related to the heuristic "Flexibility and efficiency of use", user 4 reported, with a severity of 2, that, assuming the map of the school would be draggable, it would be better to display, when clicking a friend's avatar or by viewing their profile, in what zone of the school they were to make the process more efficient. Although the map is not draggable, meaning that the user is limited to the top view of the school, dividing the map of the school into sectors and placing the friends' avatar in a certain sector not displaying their actual position is a very interesting idea, since it could potentially make the user interact with more friends, instead of knowing that there is someone in a specific position he now knows that there are multiple friends in a sector but not where exactly.

Related to the heuristic "Visibility of system status", user 3 reported, with a severity of 2, that just by looking at the map displayed while inviting a friend to form a team, it is not clear if the user is close enough to that friend without clicking on his avatar and receiving a message displaying that information. We completely agree with this statement, by clearly showing the user if he is or not in range to invite another user is important visual feedback, avoiding possible unnecessary interactions with the application.

It is worth mentioning that, unlike the previous evaluations, testers did not report problems related to the friend sticker collection page, in fact, two of the users emphasized how much simpler it became since the previous iteration. A more detailed description of each expert's evaluation can be found in appendix E on page 111.

Another evaluation session, once again using the cognitive walkthrough method (2.6), was arranged with only one of the therapists this time. The session was composed of 5 tasks and the difficulty levels continued to range from 1(very easy) to 4(very hard). All tasks were related to how she perceived the latest version of the friend sticker collection page. Similarly to what was reported by the Computer Science students, the therapists also mentioned that the interface was much more intuitive than before, assigning a difficulty level of 2 to every task. A more detailed description of the tasks is displayed in appendix F on page 118.

4.7   Proof of Concept Development

Having reached a final version of the mockups, it was time to actually develop and implement the desired changes in **AMICA**. In order to do so, the technologies mentioned in section 4.2 were used, following the architecture specified in section 4.1. From the set of features previously defined, the challenges "Jogo da Fruta", "Defensores do Espaço", and "Jogo do Sério" were the only elements not to be implemented. During development, we felt the need to make certain changes and improvements which were not originally specified on the mockups, therefore, we decided to make the application undergo further iterations and evaluation sessions.

4.7.1   Basic Feature Development

Development started by changing **AMICA**'s default aspect, as evidenced in figure 4.27, followed up by the implementation of the "Caderneta de Cromos" and the "Onde estão os meus amigos?" features.
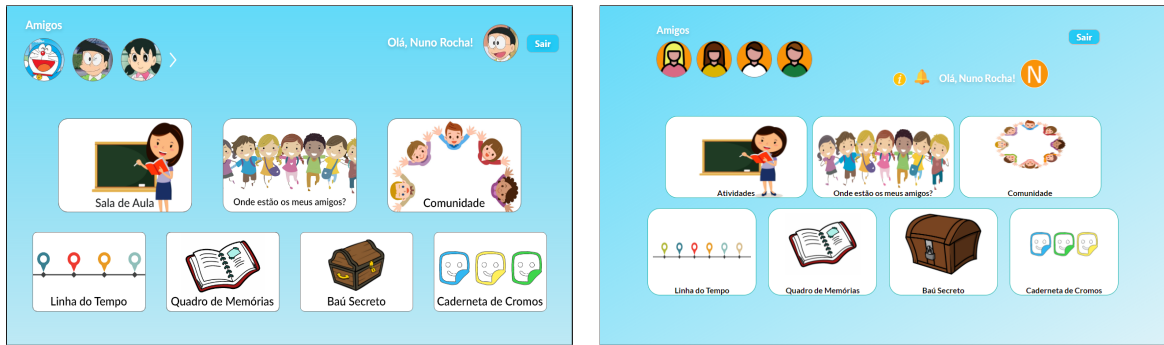
(a) Final "Inicio" page mockup

(b) Implemented "Inicio" page

Figure 4.27: Comparing the final mockup (4.27a) and implemented (4.27b) versions of the "Inicio" page

"Caderneta de Cromos"

The development of the "Caderneta de Cromos" feature consisted mainly on the creation of a service responsible for retrieving and updating information related to the users' sticker collections, as well as delivering information regarding possible teammates for each sticker part. The database associated with this service considered each sticker as belonging to a certain collection, meaning that the system is ready to cycle through multiple collections of stickers in case the themes of the stickers want to be changed.
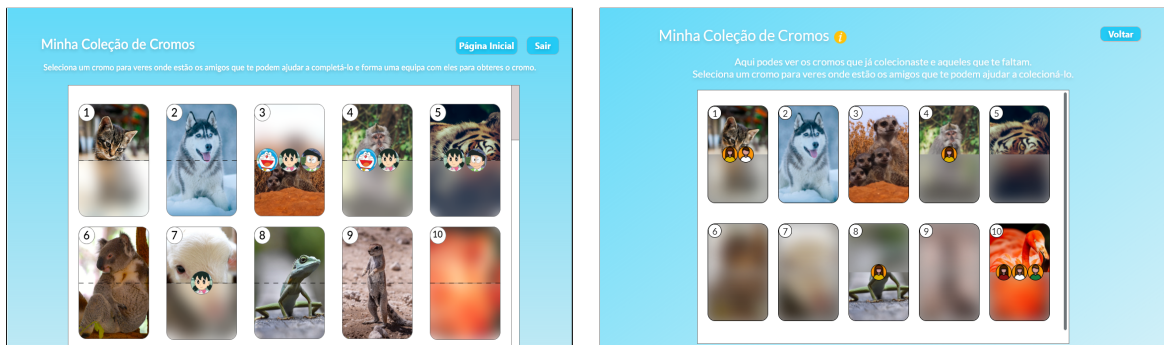
(a) "Caderneta de Cromos" final mockup page

(b) Implemented "Caderneta de Cromos" page

Figure 4.28: Comparing the final mockup (4.28a) and implemented (4.28b) versions of the "Caderneta de Cromos" page
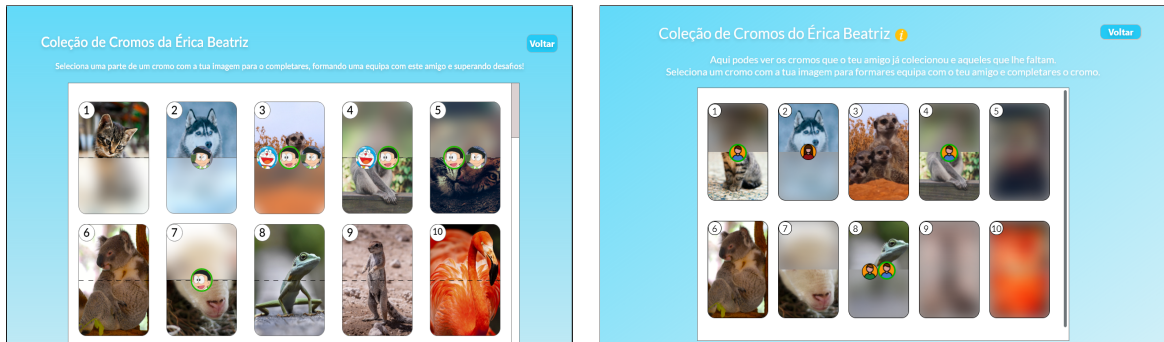
(a) Friend's sticker collection final mockup page

(b) Implemented friend's sticker collection page

Figure 4.29: Comparing the final mockup and implemented versions of the friend's sticker collection page

The page displaying every possible teammate and their location was also updated to clearly show if a user is in range to be invited or not, as requested in previous feedback. This range was defined as 6 meters since we want users to stay close to each other while undergoing challenges.
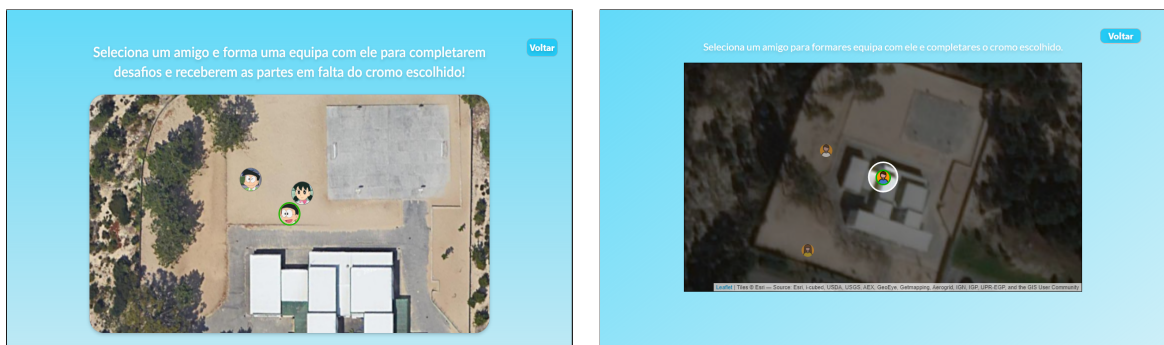
(a) Final team invitation page mockup

(b) Implemented team invitation page

Figure 4.30: Comparing the final mockup (4.30a) and implemented (4.30b) versions of the team invitation page

It is worth noting that, on this page, the avatars of the possible teammates are clearly displayed because the user already knows who is able to help him. His avatar is also significantly smaller, compared to the ones represented in "Onde estão os meus amigos?" feature map, so as to communicate more precisely where they are located and for the user to be able to check if they are inside the specified radius (6 meters).

"Caderneta de Cromos" Challenges

Regarding the feedback gathered from the interviews with the therapists (appendix A), another challenge was developed, named "Jogo da Memória".

Challenge: "*Jogo da Memória*"

"Jogo da Memória" is a cooperative challenge where the objective is to flip every card, one per turn, by finding their respective pairs, the other card that has the same image as the one flipped. After finding all pairs, they must answer a question related to their own interests and their friend's, completing the challenge.
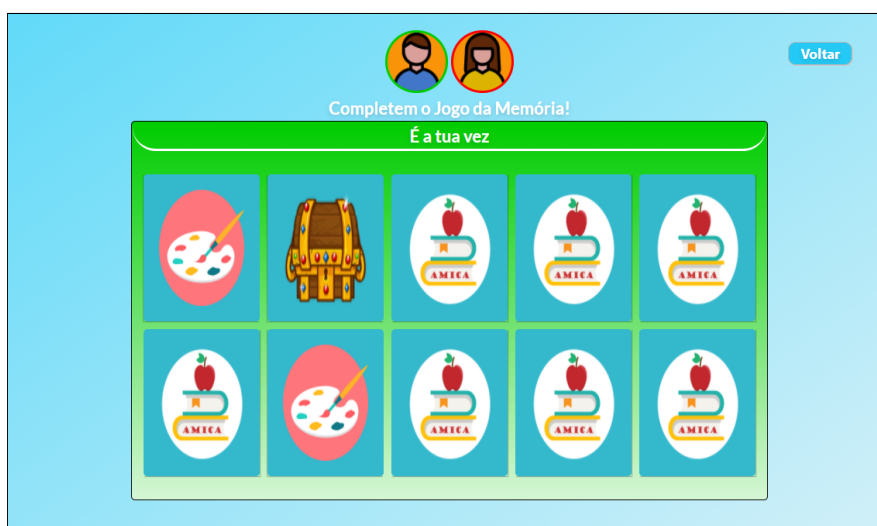
Figure 4.31: "Jogo da Memória" page

The instructions to play and complete the challenge are depicted below.

Instructions

A set of ten cards, each with a figure (there are five different figures in total, every two cards share the same image), are placed face down. Player 1 and player 2 take turns in selecting a card to flip over. If they sequentially flip cards that have the same image, those cards stay flipped. Once all ten cards are flipped over, the system will display a question to both player 1 and player 2, on their respective tablets, regarding their own interests (the question is the same for both). After answering the first question, a second one appears regarding the other player's answer to the previous question. By correctly answering the second question the challenge is complete.

Examples of questions are:

- "What is your favorite color?" and "What is your teammate's favorite color?";

- "What is your favorite superhero?" and "What is your teammate's favorite superhero?";

- "What is your favorite movie?" and "What is your teammate's favorite movie?";

- "What is your favorite book?" and "What is your teammate's favorite book?".

Social Skills in Use

This challenge makes use of the following social skills:

- Space and proximity;

- Asking questions.

- Sharing interests.

It is worth noting that, both the "Jogo do Tesouro" and the "Jogo da Memória" challenges, involve questions related to the user's personal tastes. Therefore, the information shared between them is stored and able to be consulted when visiting each other's profile on their interest page (figure 4.35).

"Onde estão os meus amigos?"

To develop this feature, leaflet was mainly used, not only to create the maps and their markers but also to calculate distances between the different users. It is worth noting that these calculations were made using the leaflet plugin GeometryUtil which takes the earth's curvature into consideration, minimizing possible distance errors. In order to acquire the user's position, we make use of native localization features existing on the devices used to develop these features, tablets. Once the user's coordinates, latitude and longitude format, are acquired, they are stored in the database associated with the user related service. This is how we are able to pinpoint a user's location inside the school perimeter.
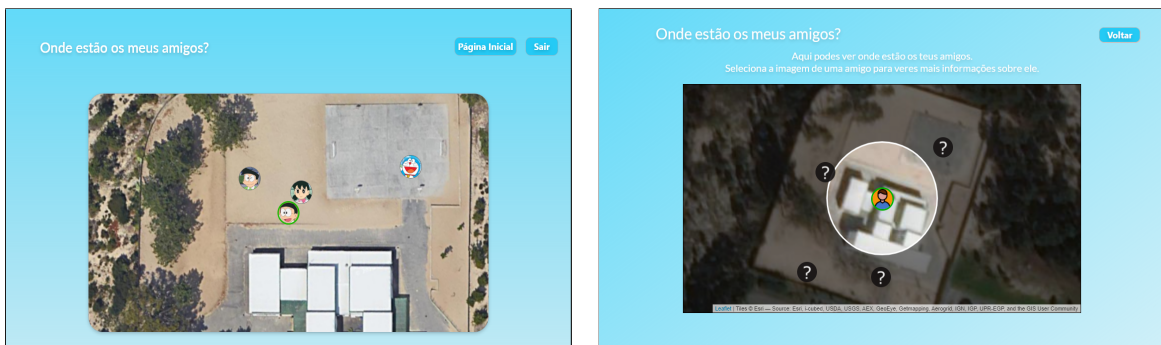
(a) Final "Onde estão os meus amigos?" page mockup

(b) Implemented "Onde estão os meus amigos?" page

Figure 4.32: Comparing the final mockup (4.32a) and implemented (4.32b) versions of the "Onde estão os meus amigos?" page

The maximum distance a user can be from one another, in order to find who they are through the application and to view their sticker collection is 25 meters. This number was chosen taking in mind the school perimeter, not allowing a user to check a friend's sticker collection without first getting closer to him, but not forcing them to be extremely close to one another. Here, friends further away than 25 meters from the user, have their avatar hidden. This is to motivate the user to search for them, possibly giving origin to social interaction opportunities with different friends.

User Profile

The user profile page was implemented as it was presented in its final prototype (figure 4.25).
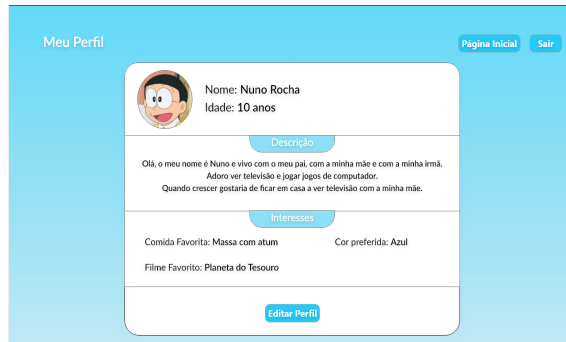
(a) Final user profile page mockup

(b) Implemented user profile page

(c) Implemented user profile page (editing)

Figure 4.33: Comparing the final mockup (4.33a) and implemented (4.33b and 4.33c) versions of the user profile page

The friend profile page now displays the interests shared with the user in a separate window (figure 4.35).
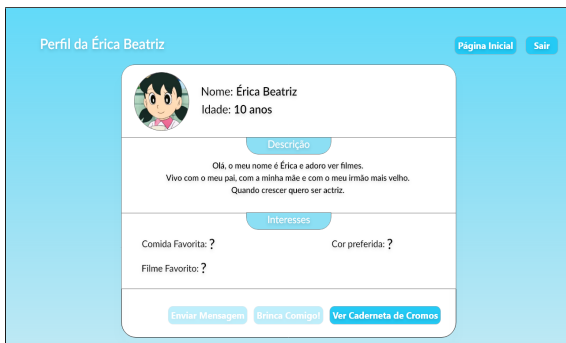
(a) Final friend profile page mockup
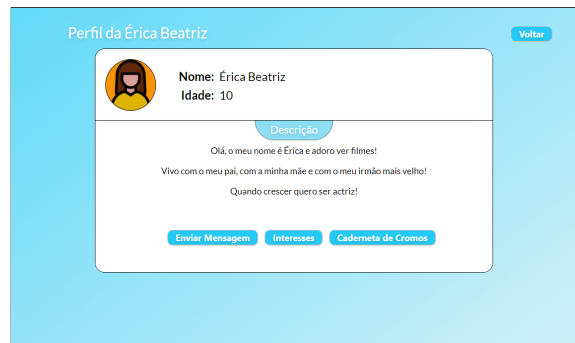
(b) Implemented friend profile page

Figure 4.34: Comparing the final mockup (4.34a) and implemented (4.34b) versions of the friend profile page
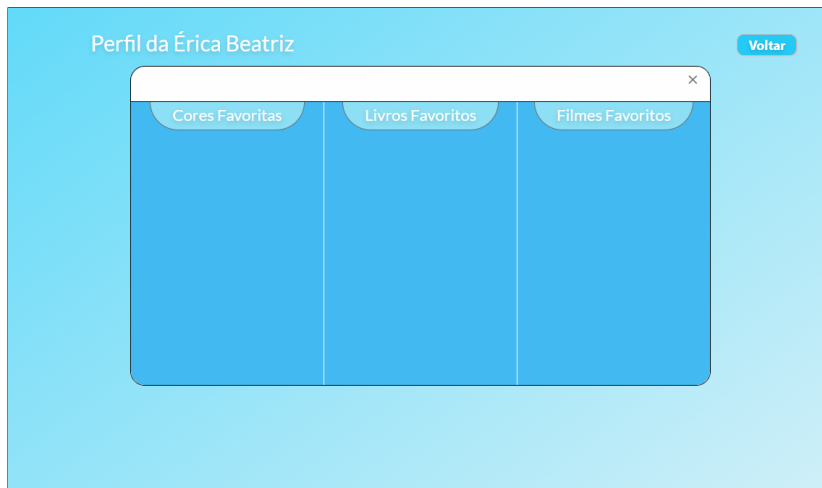
Figure 4.35: Shared interests window

Chapter 5

Proof of Concept Evaluation

5.1 Preliminary Evaluation with Professionals

In order to validate the new additions made to the proof of concept and understand if it was ready to be tested by actual end-users, we decided to schedule a meeting with one of the therapists that had participated in previous mockup evaluation stages. In this meeting, an informal evaluation, alongside a discussion regarding the preparation details for the future session with end-users, was held.

For the evaluation, we brought two tablets, one for the teacher and one for myself. This was done to provide the therapist with a hands-on experience, allowing her to not only interact with the application, but with the devices later used in the session with the end-users as well. She was initially tasked with interacting with the application freely, thinking aloud while doing so, and pointing out anything she thought the end-users would struggle with, such as understanding the instructional texts and interface elements. Aside from changes related to the wording present in the "Caderneta de Cromos" feature, no other issues were evidenced during that first interaction.

By having both tablets, the therapist was also able to fully experience the developed features. To do so, a second, and final, set of tasks, related to forming a team, surpassing a challenge, and viewing other users' interest, were given to the therapists, myself being the other user. While undergoing these tasks, just as before, she was asked to think aloud. She was successful in completing the mentioned tasks, inviting my user to form a team and surpassing a challenge ("Jogo da Memória"), suggesting changes to the wording on its instruction page. Finally, she was able to access my user's interests, shared on the previous challenge, and was particularly excited by this feature, since it was aligned with her feedback from previous sessions (appendix A). In the end, the therapist was glad with the final result, mentioning that it was ready to be evaluated by actual end-users.

5.2 End-User Evaluation

After the previous iterations, the developed features were ready to be tested by actual end-users.

In order to actually access the role of technology in including users from different audiences in the same group, the ideal end-users should belong to distinct audiences. Combining this requirement with the target users that guided **AMICA** through its development process,

an ideal environment, for a hands-on test of the mentioned features final iteration, should involve at least two children, each belonging to a different audience. We contacted one of the interviewed therapists to evaluate the possibility of arranging a session involving our team, the therapist, and two of the children that attend her therapy sessions. Fortunately, the therapist was not only able to organize said session, but she also invited children from two different audiences, children with an without **ASD**, to test the developed features. An informed consent, related to how the session would occur and its purpose, was sent to both children's parents and after their approval, the session was scheduled.

5.2.1 Session Preparation

Before the session, we decided to modify **AMICA**'s interface to only contain the developed features, this decision was made in order for users not to deviate from the features to be tested.

Figure 5.1: **AMICA**'s home page for the session

Since the application was going to be tested by 2 different users at the same time and in order to create a test scenario as close as possible to a potentially real scenario where **AMICA** could have been deployed, we were able to bring the same two tablets used in the previous evaluation session with the therapist (section 5.1), one for each user. Application accounts for both children were also created in the system, with only their general information (first and last name, age and email accounts created by us). Avatars with the first letter of their first name were also created for each user.

(a) User P avatar   (b) User M avatar
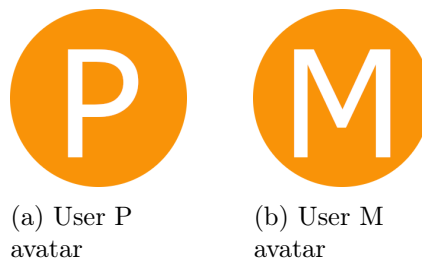
Figure 5.2: Created user avatars

The session occurred indoors, meaning that, from the implemented challenges ("Jogo do Tesouro" and "Jogo da Memória"), only the "Jogo da Memória" challenge could be executed. In order for that challenge to be picked by the application, we disabled the random challenge selection feature.

The therapist was aware of these changes and, in preparation for the session, multiple application flows, such as completing challenges, acquiring stickers, and checking each other's interests, were tested by her and myself.

5.2.2   Session Details

As mentioned, the session took place indoors and involved four people, the therapist, both children, and myself. The children were given the tablets and the therapist started by introducing the application to both children, regarding its purpose and how it would be used in a real scenario. Because the features related to a user's position still displayed their location on an image of the top view of a school, which was not the case, the therapist explained the situation and asked the children to imagine they were on their school's playground.

Initially, the therapist and I asked the children to interpret what each button of the home page ("Inicio" page) would do, based on their icons and titles, if they interacted with it. Although both participants easily guessed the behavior of the "Onde estão os meus amigos?" feature, it was not so simple to do the same for the "Caderneta de Cromos". After their deductions, without them knowing if they were right or wrong, we allowed them to freely explore the application for 2-3 minutes, so that they could get accustomed to the interface and for us to observe their behavior during the process, paying close attention to what they pointed out while interacting with the application. It was noticed that, once they were faced with the "Onde estão os meus amigos?" feature page, they began asking questions related to their position on the map of the school and who were the people represented by the other circles.

Figure 5.3: "Onde estão os meus amigos?" session context page

The therapist quickly intervened and reminded them that, in a real scenario, when using the application, each child could be in different places of the school at a given time and that they would be able to see the positions of their other friends as well, also mentioning that the specific positions they were placed on the map were merely illustrative. On this page, both children took the liberty of interacting with each other's avatar to see what would happen. They noticed the popup window and started by accessing each other's profiles. Here they decided to view the other user's interest and questioned why it was empty. This question was

answered as soon as they completed a challenge together and revisited this page. Afterward, one of the participants (user P) decided to access the "Caderneta de Cromos" feature from the home page, while the other pressed the "Ver cromos" option on the other user's profile.

(a) "Caderneta de Cromos" on user's P device
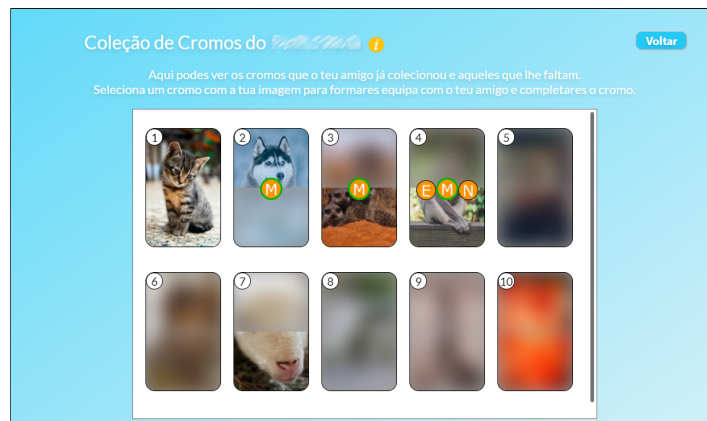
(b) "Ver cromos" on user's M device

Figure 5.4: Perspective of both users

Upon observing the stickers, they were excited to see the sticker images represented animals, questioning each other what animals were shown in each sticker if they had both parts. After reading the text at the top of the page and clicking on the "Additional Information" icon, they understood that each sticker was composed of 2 individual parts and that they could acquire their missing parts by forming a team and successfully completing a challenge. The notion that each circle in the middle of certain stickers represented the friends that could help them acquire that specific part, on the other hand, was harder for them to understand at first. This was due to the fact that, by changing each registered user avatar to a single letter, instead of their face, ended up forming words when the images were put side by side.

Figure 5.5: Sticker with the helper avatars forming a "word"

After we clarified the meaning of the circles in the middle of the stickers, they understood the concept and confirmed it once they selected a sticker and realized that the same avatars that appeared on the circles, were also shown as available friends to form a team with on the map.

Figure 5.6: Same helpers displayed on the map

Participant M invited participant P to form a team and, after reading and understanding the "Jogo da Memória" challenge instructions, they began the challenge. During the challenge, it was noticeable that participant M was being quite impulsive, wanting to select multiple times instead of waiting for participant P but because this is a turn-based challenge, where each user must wait for their teammate to flip a card of their own choosing, participant M had to wait for his turn. When this situation occurred, the therapist emphasized that the turn-based characteristic of this challenge is very interesting because it not only made users aware of the existence of turn, which may be applied in social interaction as taking turns in speaking during a conversation, but also made them understand that without their teammate they would not be able to complete the challenge.

They successfully matched every card and the personal interest related questions were displayed. The randomly selected question was related to their favorite movie, "Qual é o teu filme favorito?", and although both participants had no trouble in answering it, participant P

mistakenly confirmed his answer before inputting his complete answer and was worried about it. I intervened by saying that there was no actual issue, but in case the application requires that information to be shared, he just needs to mention the name of his favorite movie as he wrote it in his answer. With the first question answered, it was time for the second one, "Qual é o filme favorito do teu amigo?". As previously mentioned in subsection 4.7.1, the second question of this challenge is always about the same interest as the first one, their favorite movie in this case, but related to the teammate.

It was very interesting to follow participant's P reasoning through his following interventions upon reading the question. He asked how could he know participant's M favorite movie if he did not know him, to which the therapists replied by emphasizing that same fact, that they did not know each other but it had to be a way to acquire that information. At that moment participant M replied that by asking him directly he could know the answer, "Se lhe perguntar consigo saber a resposta.", evidencing the need for social interaction between the team members in order to complete the challenge.

They both asked directly to each other what were their favorite movies, writing the answer, and successfully completing the challenge. After that, they were redirected to their own sticker collection where they noticed the newly added sticker part for undergoing and completing a challenge. We asked questions regarding their interpretation of the sticker collection, in particular, which stickers they thought they had, the ones that were incomplete, and finally the stickers which were completely missing from their collection. Both participants answered correctly to the proposed questions, revealing that they clearly understood the interface and the given visual feedback.

Later on, participant M asked why he could not form a team with participant P in order to complete sticker number 7 since he was missing the second part of it. This question was answered by participant P himself, which correctly mentioned that because he did not own the part participant M was missing, he could not help him complete it. Following up his own reply, participant P also mentioned that it would be fun to help friends complete stickers even if they do not have the corresponding part.

After reviewing their sticker collection, both participants were asked to view their friend's interests, it was not necessary to remind them how to access them. Unfortunately, a mistake that had been overlooked was found while observing each other's interests, they were swapped, participant P saw his own interests in participant's M page, and the same was happening the other way around, but they were quick to point that mistake out, saying the interests were swapped.

Figure 5.7: Participant's M interests acquired by participant P

At the end of the session, I asked both participants if they had enjoyed the time they had interacting with the application to which both replied they had enjoyed it very much, participant P even pointing out that he wanted to collect another sticker but, unfortunately, the session had to end. The therapist also asked if they thought such an application could help them get to know other classmates that they had never talked to before, to which they both agreed.

To the last question regarding what other types of challenges they would like to see, participant M answered that it would be interesting to have games related to solving social conflicts, that is, games where the user was given social stories revolving around a certain conflict and the user had to pick the most appropriate action for that situation. This suggestion was extremely interesting in my opinion, since it is very similar to one of the functionalities initially proposed that unfortunately was not implemented.

The session ended and both children, that did not know each other before the session, left the same session talking to one another and knowing more about the other.

5.2.3   Session Results

As a result of this session, we were able to have our proof of concept tested by actual end-users. Although we were only able to test the developed features with two end-users, their feedback and behavior, as well as the therapist's observations and overview of the session, helped us understand that not only did collecting the stickers motivate its users to undergo more challenges, therefore making them engage in more social interactions, but also that challenges can be developed to tackle broader issues which may not be directly related to the selected social skills, such as impulses, but may reflect on their behavior during social interactions. It was also fascinating seeing how excited both participants were to share their own personal interests. Not only because they were talking about a particular interest of theirs but also because, while thinking about which movie was their favorite, they enumerated other movies that they also enjoyed, leading them to share more information regarding the same theme with their teammate.

5.2.4   Discussion

This session was only possible thanks to the therapist, not only did she provide an incredible amount of feedback during the development of the proof of concept and during the session, but she also managed to find a locale for the session to occur and invite both participants, even fulfilling our requests regarding them. If the current circumstances allowed, perhaps the number of participants could have been higher, leading to the observations of other people's reactions and behaviors, and consequently to the acquisition of more feedback to better determine the impacts of the proof of concept. Nonetheless, the participants involved in the session were an outstanding source of feedback.

Chapter 6

Conclusions

6.1 Conclusion and Future Work

Communication plays a pivotal role in the establishment of relationships between us. Being such a crucial component to our survival, those that are unable or have difficulties when doing so, face multiple obstacles throughout their day to day life. Blocked by those obstacles created by inherent difficulties, manifested through abnormal social behaviors, for example, the feeling of inclusion may be harder to grasp for those that experience them.

As technology evolved, so did our ways of communicating with each other. Since nowadays it is extremely easy to communicate with others while not needing to be physically standing near them, there are certain social behaviors and certain steps that comprise social interaction that can be skipped while communicating through those means. This is not a good representation of what a social interaction should be for children in general, especially for those that also inherently display communication issues and are faced with a continuous need to rely on these tools. Unfortunately, and according to the exploratory work conducted, features focused on developing the user's social skills and motivating their usage are not typically found in the scope of those tools.

To help better understand the impacts that technology may have on assisting its user feel integrated in a group, a proof of concept has been developed, through an iterative user-centered design approach. This proof of concept, taking into consideration the relationship between communication and integration, the users to whom it was developed for, and validated practices used on therapy contexts, was designed to motivate its users to engage in cooperative activities, through a reward system based on collecting stickers, requiring them to make use of crucial social skills that compose a "basic social interaction" while doing so.

While the implemented proof-of-concept already provides a demonstration of the proposed features, the conceptualized approach, as depicted in the full set of scenarios goes beyond what was possible to accomplish, during the time span of this dissertation. This portfolio of ideas along with the positive feedback from users can work as grounds for immediate action in evolving the proposed system.

Considering the work carried out through several iterative stages of prototyping and evaluation, leading to a first positive evaluation with end-users, and the publication of preliminary results in an international conference, we consider that the objectives for this dissertation have been fully accomplished, emphasizing the role of technology as a cognitive prosthetic but also providing potential approaches of promoting social skill development.

Finally, and considering the importance of progressively move into more ecological evaluations, e.g., with children using the system in more natural environments and with less direct intervention of the observer/educator, methods should be proposed not only to support the collection of relevant data related to the user's behavior regarding system usage, which may derive import conclusions for clinical context but to also allow a wider range of interaction possibilities, supporting multiple types of communication that adapt to the user and/or his context.

Based on the feedback received throughout the development of this dissertation, mainly from the interviews (appendix A) and the evaluation session with end-users (5.2), other, more detailed features can be derived, as being important future additions to this work. An example of such a feature is one where the user could be given a social scenario, being able to choose which action would be the correct one according to the situation described. A feature similar to this one, named "Brinca Comigo", where the user would be able to interact with a virtual character which would ask him questions regarding the appropriate behaviors to have depending on the situation, was initially proposed to be developed, but the idea was later abandoned due to time constraints. Nonetheless, it is an interesting feature that was also brought up by one of the end-users, emphasizing the need for such a feature. Another feature that was initially suggested to be implemented, was the ability for users to send pictograms when using the **AMICA**'s online chat function. The capability to translate said pictograms to text by the application was also thought of but, unfortunately, such features were not developed due to time constraints as well.

In order to have the user employ social skills different from the ones the developed features already do, new and engaging challenges should be created. By doing so we will not only be motivating the user to apply other social skills but, by adding more challenges to the application, users are able to experience a more varied set of games and activities, avoiding repetitive experiences. The creation of challenges designed to tackle a wider range of issues, not strictly related to social interaction, would also be considered a beneficial addition to the application.

Design and improvement of features with the goal of assisting therapists detecting certain behavioral patterns in children, for example, is another route the development of an application, such as **AMICA**, can take. By making use of the already developed feature "Onde estãos os meus amigos?", it is possible, for instance, to record a user's movement throughout the days, and derive multiple conclusions regarding their preferred locations to be while at the school, with which friends does he usually interacts with, if the child shows signs of isolating her self, and many more. It is worth noting that such features/improvements would be handling extremely sensitive information, requiring authorization, therefore, if future developments go further down this path, security precautions regarding the disclosure of such information should be taken.

In regards to tracking a user's location, it is also important to mention that, when using GPS signals to do so, limitations related to its positioning accuracy indoors are also imposed [49, 50]. This may pose a problem when acquiring the positions of users inside the school building for example. Given these constraints, two different solutions were proposed when developing the "Onde estão os meus amigos?" feature but were not implemented.

Appendices

Appendix A

Interviews

A.1   Terapeuta A: Entrevista

Miguel: Antes de mais, gostaria de saber qual a sua experiência profissional nesta área?

Terapeuta: Eu comecei a trabalhar com a perturbação do espectro do autismo há cerca de 9 anos. Comecei por me licenciar em Educação Especial e de seguida comecei a trabalhar num hospital, numa unidade de neurodesenvolvimento. Mais tarde licenciei-me também em Psicologia.

Portanto, sempre tive contacto com esta população, mas muito dentro de um contexto médico de avaliação, ou seja, famílias que iam ao pediatra de desenvolvimento porque haviam queixas de alterações na linguagem ou dificuldades na interação social, eram encaminhadas pela médica para mim, para que eu as pudesse avaliar. Continuo, ainda, a trabalhar nesta área de avaliação.

Associada à avaliação, comecei a fazer intervenção também, só que a experiência que eu tenho com a perturbação do espectro do autismo, é mais relacionada com crianças altamente funcionais.

À quase 10 anos que acompanho estas famílias, que avalio e faço o diagnóstico. Trabalho em conjunto com escolas também, para perceber, em termos de sala de aula e de outras questões como comportamento e aprendizagem, que mais é que a escola pode fazer para ajudar estas crianças e jovens. Mais recentemente, tenho-me dedicado à parte dos adolescentes, adolescentes estes com perturbação do espectro do autismo que têm dificuldades nas competências sociais e que frequentam as consultas para aprender competências que não são intuitivas para eles.

Miguel: Relativamente às sessões de acompanhamento que faz, estas costumam ser de forma individual ou em grupo?

Terapeuta: Normalmente a intervenção é de um para um, contudo, para que estas crianças e jovens trabalhem e tentem generalizar ao máximo as competências que aprendem em consulta, nós criámos, desde há 2 anos para cá, sessões de grupo. Apesar de acontecer apenas uma vez por semana, tenho um grupo de, normalmente, cinco jovens que junto e as sessões são em grupo, porque acho que faz sentido porem

em prática o que aprendem nas consultas individuais. Para estas sessões, são dinamizadas atividades para trabalharem as competências em conjunto.

Miguel: Que atividades são essas e que formas tomam?

Terapeuta: Nós, sempre que as sessões de grupo terminam, tentamos perceber, dentro dos nossos objectivos, o que é que há a melhorar e o que falta ser trabalhado. No inicio começámos de forma muito ambiciosa, com o objectivo de trabalhar todas e quaisquer competências, mas como se tratam de crianças que, muitas vezes, apresentam outros diagnósticos associados também, percebemos que o objectivo principal deveria ser fazer com que cada uma das crianças partilhasse o sentimento de pertença a um grupo. Para que tal objectivo fosse atingido, promovemos várias atividades que vão desde jogos de "Role-Play", em que as crianças são "colocadas" em diversos cenários que envolvam interações sociais, até jogos que as próprias crianças trazem de casa para partilhar com os restantes elementos, sem grande intervenção nossa nesses casos. As sessões começaram dessa forma, mas actualmente temos tentado seguir programas de competências sociais já existentes e testados. Este ano aplicámos um programa chamado "Tartaruga - Devagar se vai ao longe" que contem uma série de atividades propostas que nós usamos, que vão desde perguntas como "Quem sou eu?", "Quem é o outro?", "Quem sou eu com os outros?", perguntas relacionadas com as emoções básicas e como é que devem ser transmitidas e em que situações.

São programas muito abrangentes, envolvendo também jogos de equipa com desafios mais lúdicos, mas o principal objectivo é sempre trabalhar mais estes conteúdos sócio-emocionais porque, quem apresenta perturbação do espectro do autismo, costuma demonstrar muita dificuldade em perceber o que é que o outro sente, qual é o impacto das suas palavras e ações, sendo muito importante fazer este treino das competências mais ligadas à parte emocional.

Miguel: Começaram então com uma abordagem criada por vocês e agora seguem um programa já existente e testado.

Terapeuta: Este programa que referi, não é específico para crianças com autismo. Foi feito para crianças de várias idades, apresentado também atividades em função dessas idades. Nós escolhemos e adaptamos algumas dessas atividades, aquelas que sabemos que podem resultar nas nossas crianças.

Miguel: Acha que estas crianças se sentem motivadas a socializar com outros?

Terapeuta: Existem muitas crianças e jovens inseridas no espectro, que querem ter amigos e interagir, sendo que, muitas vezes, o obstáculo não é a motivação mas sim como agem socialmente.

Miguel: Acha importante a existência de um "manual de instruções" de auxílio à interação social?

Terapeuta: Está dependente de vários fatores, desde a abordagem até à cognição da criança. A existência de algo extra como uma tabela por exemplo, pode ajudar em certos casos. Um caso exemplo é o de uma criança que acompanho, a criança tem

perturbação do espectro do autismo, mas não apresenta qualquer tipo de dé-fice cognitivo. Ela repete-se várias vezes ao longo do mesmo diálogo e uma das soluções que criámos para o ajudar foi a apresentação de uma tabela onde es-tão registados os comportamentos a serem trabalhados naquele momento, sendo que a introdução de assuntos já falados não podem ser novamente introduzidos. Tornando esta tabela visível para a criança também, apresenta efeitos no seu comportamento.

Portanto, a existência de algo que os guie não é descabido de todo e é até necessário em alguns casos.

Miguel: Acha que uma criança, com perturbação do espetro do autismo, seria capaz de primeiro se precaver e olhar para instruções, relativas a como iniciar uma interação social básica por exemplo, antes de a iniciar efetivamente?

Terapeuta: Acho, mas tem de ser um treino que, normalmente, precisa de uma primeira abor-dagem mais individual. Deve ser feito, previamente, todo um trabalho teórico à volta desse tema, entre criança e psicólogo por exemplo, para que eles se aperce-bam qual o propósito por detrás da ação que vão executar. Perguntas como "O que é que é um amigo?", "Como é que faz um novo amigo?", "Porque é que é importante ter amigos?", são exemplos de questões que devem primeiro ser tra-balhadas com a criança. Ao treinar o contacto visual com estas crianças, primeiro deve ser explicado qual o propósito e a importância do contacto visual, antes de se adoptar por uma abordagem mais prática, reforçando o propósito das sessões em grupo.

A.2   Terapeuta A: Avaliação do protótipo - Feedback

Terapeuta: O conceito de permitir que as crianças se formem em equipas e enfrentem desafios e m conjunto que promovam o contacto social entre eles, é muito interessante.

Terapeuta: Deve-se arranjar uma forma de garantir que todas as crianças da turma aderem a todo este jogo de colecionar os cromos. Talvez uma primeira abordagem por parte da professora aos alunos a explicar que toda a gente tem um papel importante a desempenhar no jogo e que poderão fazer com que as competências sociais de todos melhorem.

Terapeuta: As crianças, ao fazerem escreverem a sua descrição devem ser monitorizadas para que não sejam divulgadas determinadas informações que, no contexto da apli-cação, não são as mais úteis. Os balões na funcionalidade "Onde estão os meus amigos" poderiam apenas apresentar o nome e os gostos da criança em vez de toda a informação.

Terapeuta: Os perfis dos amigos podiam também ser completados pelo utilizador, ou seja, para saberes quais os gostos de um amigo, terias de lhe perguntar primeiro, só depois é que essa informação iria aparecer no perfil dele.

Terapeuta: A caderneta dos amigos apresenta demasiadas variáveis, ficando muito confusa, mostrando não só elementos que pertencem exclusivamente à caderneta do colega mas também da minha. Penso que se devem apresentar os cromos segundo o objectivo principal ao ver a caderneta de um amigo, visto que, neste caso, o objectivo principal de um utilizador será, em princípio, ver que cromos é que o colega tem que eu não tenho para que este consiga completar a sua caderneta. Sendo assim, mostrar todos os cromos que o colega tem, revelando eventualmente partes de cromos desconhecidas, é a melhor opção.

Terapeuta: Seria muito interessante existir uma forma de ajudar um amigo, a obter um cromo por exemplo, sabendo que não vou ganhar nada com isso, retirando, um pouco, o aspecto de competitividade envolvido, porque ajudar os outros sem traga qualquer benefício para mim, é também algo muito importante que deve ser trabalhado.

Terapeuta: Juntar a diversão do desafio "Defensores do Espaço" com as perguntas feitas no desafio "O Jogo da Fruta" seria uma boa adição.

Terapeuta: O último desafio ("O Jogo do Tesouro") é muito interessante, pois apresenta questões que eu própria promovo quando estou em sessões de grupo. É principalmente neste desafio que vê o potencial desta plataforma. As repostas às perguntas aqui colocadas poderiam ajudar a preencher o perfil dos teus colegas.

A.3 Terapeuta B: Entrevista

Miguel: Antes de mais, gostaria de saber qual a sua experiência profissional nesta área?

Terapeuta: Licenciei-me em terapêutica da fala em 2008 e iniciei a prática profissional também nesse ano, na área clínica. Mais tarde passei também a trabalhar em escolas, mais direcionado à unidade de autismo e à unidade de multideficiência.

Miguel: Essa foi a sua primeira experiência a trabalhar com crianças com perturbação do espectro do autismo?

Terapeuta: Não, anteriormente também já tinha tido a oportunidade de trabalhar com crianças com perturbação do espectro, mas em contexto de gabinete, sendo aplicadas abordagens completamente diferentes neste contexto versus no contexto escolar.

Miguel: Relativamente às sessões de acompanhamento que faz, em contexto escolar, estas costumam ser de forma individual ou em grupo?

Terapeuta: Das duas formas, sendo que em algumas das sessões de grupo, principalmente em contexto de recreio, eram também envolvidas crianças neurotípicas, de forma a promover a inclusão.

Miguel: Que atividades eram realizadas nessas sessões de grupo?

Terapeuta: Eram feitas várias atividades, sendo que o objectivo era o mesmo, de trabalhar as componentes sociais das crianças, envolvendo a comunicação, linguagem, entre outras. Um exercício que era aplicado várias vezes era integrar estas crianças em "brincadeiras" que outras crianças já estavam a ter, mais uma vez para promover

a inclusão. Outras atividades envolviam também a prática de turnos, em que eram passados objectos de uns para os outros, sempre de forma diferente. Não seguia nenhum currículo em particular, aproveitava as "brincadeiras" que eles gostavam para trabalhar a suas componentes sociais.

Miguel: Acha que estas crianças se sentem motivadas a socializar com outros?

Terapeuta: Depende de caso para caso, desde a retaguarda familiar, do apoio que existe, do que é trabalho na escola e terapias, da capacidade cognitiva da pessoa.

Miguel: Acha importante a existência de um "manual de instruções" de auxílio à interação social, manual este que seria usado para a criança, antes de iniciar uma iteração social, se precaver e olhar para instruções, relativas a como iniciar uma interação social básica por exemplo?

Terapeuta: Está também dependente da pessoa e da sua cognição, mas isso são objectivos que se trabalham em terapia, ou seja, é suposto serem trabalhadas essas componentes pois, se não conseguir desenvolver essas capacidades de forma manual e estímulos, um manual também não será uma solução. Existem, sim, métodos de comunicação alternativa, para aqueles que não possuem linguagem verbal oral, que somos nós terapeutas da fala que fornecemos, como livros com símbolos e pictogramas, mas um manual com instruções propriamente ditas não.

A.4   Terapeuta B: Avaliação do protótipo - Feedback

Terapeuta: Relativamente ao desafio "O Jogo do Sério", o contacto ocular entre ambos não é direto, ou seja, é feito através do tablet e não diretamente, obrigando as crianças a manter contacto ocular com o tablet e não com a outra pessoa.

Terapeuta: As instruções de alguns desafios estão demasiado extensas para uma criança ler.

Terapeuta: Seria interessante haver vários temas de cromos adequados aos gostos gerais da turma por exemplo.

Terapeuta: A existência de um perfil para cada criança tornaria certas ações, como ver a descrição deles, mais intuitivas. Desta forma, a funcionalidade "Onde estão os meus amigos" apenas demonstrava aonde estão os amigos na escola em vez de indicar, também, uma breve descrição sobre eles, o que torna interface, na minha opinião, confusa.

Terapeuta: A caderneta de cromos dos amigos apresenta demasiados elementos visuais que apresentam diferentes significados. A caderneta de cromos dos amigos deveria ser lida exatamente da mesma forma que a minha, sendo que os indicadores visuais deveriam ser os mesmos. Como muitos das crianças com perturbação do espectro do autismo apresentam dificuldades em colocarem-se no lugar do outro e a observarem as coisas dessa perspetiva, ter representações diferentes nestes casos não ajuda.

Terapeuta: Relativamente ao desafio "O Jogo do Tesouro", seria bom arranjar um meio de garantir que quem escreve-se a resposta, fosse de encontro à realidade e não permitir que escrevam simplesmente qualquer coisa.

Terapeuta: Penso que todos estes desafios são interessantes do ponto de vista de interação social, mas jogos como o jogo da memória, que é um que costumam gostar muito, seriam adições interessantes.

Appendix B

Scenarios

B.1   Scenario 1 - Sharing user information through their profile

After recently changing schools and becoming more familiar with **AMICA**, Érica decides to visit her **own profile**. She notices that she has not changed her description and still has its default version "Olá, o meu nome é Érica e tenho 10 anos". She decides to **edit it** so that other classmates might learn more about her when visiting her profile through **AMICA**.

Although she has made many new friends, she has yet to introduce herself to some of her classmates, such a Nuno. Before approaching Nuno, she opens **AMICA** and **selects his profile**, where she can see his name, age and a brief description about him. Based on his profile, Érica learns that both of them have the same age and, with this information, she decides to engage Nuno, introducing herself and highlighting the fact that they share the same age. Érica and Nuno are now interacting with each other.

Scenario describes how the application can be used to help Érica fulfill the following use cases:

- See own profile (see use case C.1 on page 86);

- Edit profile description (see use case C.2 on page 87);

- See friend's profile (see use case C.3 on page 87).

B.2   Scenario 2 - Engaging in cooperative activities

Gabriel arrives early to school and decides to check if Nuno has already arrived as well. Gabriel opens **AMICA** and clicks the "Onde estão os meus amigos?" option. Here he sees a top view image of the school and multiple circles in different places of the image. Gabriel also notices that only the circles near him have an actual picture of a friend of his, the rest have a question mark, indicating that he is not near enough to see who is at that location of the school.

One of the circles whose picture he is able to see on the map is Nuno's, indicating he is able to **see Nuno's location**, so he decides to click it. A pop up appears displaying a description of Nuno, the same as his profile, and 2 options "Ver perfil" and "Ver colecção de cromos". Gabriel clicks on the "Ver colecção de cromos" option where he is shown a list of stickers,

with the same presentation as his own collection, but **Nuno's stickers are shown** instead of his. From this list he notices that one of the circles, related to the friends that can help Nuno obtain the other part of that sticker, has Gabriel's face on it, meaning that he owns the part of the sticker Nuno is missing and Gabriel is missing Nuno's part.

By clicking on the incomplete sticker, a message is displayed asking if Gabriel wants **to invite Nuno** to form a team. Gabriel decides to do so since there is still time before their first class starts. Nuno notices the invite and accepts it. Gabriel and Nuno are now a team and they **accept their challenge**, which is **the "Jogo da Memória"**, a cooperative game where the objective is to flip every card, one per turn, by finding their respective pairs (the other card that has the same image as the one flipped). After finding all pairs, they must answer a question related to their own interests and their teammate's.

Nuno and Gabriel are able to quickly pair every card and answer correctly to the questions "What is your favorite movie?" and "What is your friend's favorite movie?". Both are awarded the sticker half they were missing for that sticker.

Scenario describes how the application can be used to help Gabriel fulfill the following use cases:

- See friend's location on the school yard (see use case C.4 on page 88);

- See friend's sticker collection (see use case C.5 on page 89);

- Inviting a friend through the friend's sticker collection (see use case C.6 on page 90);

- Accept challenge (see use case C.10 on page 93);

- Sticker collecting - "Jogo da Memória" Challenge (see use case C.11 on page 94).

B.3 Scenario 3 - Engaging in cooperative activities and being reminded of previously shared interests

A new feature was added to AMICA today, it is a sticker collection. Every student is now able to collect stickers, by joining two halves of the same sticker, until they have completed their collection, and Nuno wants to collect all of them. Nuno decides to use his tablet and open **AMICA** to check this new feature. Once he reaches **AMCIA**'s main page, he notices a button called "Caderneta de Cromos" and decides to click on it. He is **shown a list of his stickers**, each divided in two. From this list he quickly perceives that he only has half of the sticker number 1, since every other sticker part is blurred except that one.

Along with the list of stickers, additional information regarding how to obtain more sticker parts is also shown. Nuno now knows that he is able to get new sticker halves by logging into **AMICA** once a day but to actually acquire a full sticker he must find another classmate with the other half of the sticker, form a team with him and complete a challenge as a team. Nuno notices that in the middle of each incomplete sticker, between its part 1 and 2, there are circles with the faces of some of his friends, including Gabriel's. Nuno **selects the information icon** and understands that each circle represents a friend which has the other part of the sticker in question and with whom he can form a team.

By clicking on the incomplete sticker, a map of the school, showing the positions of the friends whose faces were on the circles, is displayed. Clicking their position, a message asking if Nuno wants to invite that friend to form a team appears. Nuno **decides to invite Gabriel**

so they can form a team and complete the chosen sticker. Since it was possible to invite Gabriel, it means that he is missing the part of the sticker Nuno has.

Gabriel accepts the invite on his device and they are now a team. A page explaining the challenge they will have to face is displayed, alongside two options, one to **accept the challenge** and another to decline. **The challenge is to play "Jogo do Tesouro"**, where both players, together, must reach a certain location on school, indicated by a treasure icon on the map displayed by **AMICA**. Once they reach the treasures position, they must answer a question related to their own interests and their friend's. They accept the challenge and successfully reach the spot where the treasure icon was placed and correctly answer the questions "What is your favorite book?" and "What is your friend's favorite book?". Both are awarded the sticker half they were missing for that sticker and are happy their collection is one step closer to being finished.

After completing the challenge, Nuno decides to **see Gabriel's interests**. Nuno knows from previous experience that, by accessing a friend's profile, he can either message them or be reminded of his friend's tastes regarding favorite books, movies and colours that were shared with him (Nuno). He decides to click on the "Interesses" button and look over his friend's tastes. Here he is shown 3 separate lists, each related to the interests shared by Gabriel with Nuno regarding his (Gabriel's) favorite books, movies and colors. By reading the lists he is reminded that, in the previous challenge they did together, Gabriel had answered "Toy Story" to the question "What is your favorite movie?" and decides to engage in a conversation with Gabriel related with that theme.

Scenario describes how the application can be used to help Nuno fulfill the following use cases:

- See own sticker collection (see use case C.7 on page 91);

- Get additional information regarding the sticker collection (see use case C.8 on page 91);

- Inviting a friend through own sticker collection (see use case C.9 on page 92);

- Accept challenge (see use case C.10 on page 93);

- Sticker collecting - "Jogo do Tesouro" Challenge (see use case C.12 on page 97).

- See friend's interests (see use case C.13 on page 99).

B.4 Scenario 4 - Engaging in cooperative activities (with the "Jogo do Sério" challenge)

A new feature was added to **AMICA** today, it is a sticker collection. Every student is now able to collect stickers, by joining two halves of the same sticker, until they have completed their collection, and Nuno wants to collect all of them.

Nuno knows that he is able to get new sticker halves by logging into **AMICA** once a day but to actually acquire a full sticker he must find another classmate with the other half of the sticker and complete a challenge with him. Nuno selects the "Onde estão os meus amigos?" option and checks which classmates are nearby so he can check which sticker halves they have. He finds out that Érica is close by and has one of the sticker halves he wants and approaches her.

After asking Érica if she is willing to complete the challenge with him, so that both can get the halves they are missing from the same sticker, she accepts. The challenge is to play a round of "Jogo do Sério", where both players must look to each other's eyes, through their tablets using its camera, without laughing for a set of time. They successfully complete the challenge and both are awarded the sticker half they were missing for that sticker. They are happy their collection is one step closer to being finished.

Scenario describes how the application can be used to help Nuno and Érica fulfill the following use cases:

- Sticker collecting - "Jogo do Sério" Challenge (see use case C.14 on page 100).

B.5 Scenario 5 - Engaging in cooperative activities (with the "Jogo da Fruta" challenge)

While sharing his collection with Gabriel, Gabriel points out that he (Nuno) has the other half of the sticker they just scrolled by, so both decide to do a challenge to acquire their missing halves of the sticker.

The randomly selected challenge is to play "Jogo da Fruta", a game where both players, each one on their tablet, touch the falling fruit to gather points and answer a math question related to it in the end. They gather a good amount of points and answer correctly to the question "How much points did you and your friend obtain together?" and both are awarded the sticker half they were missing for that sticker.

Scenario describes how the application can be used to help Nuno and Gabriel fulfill the following use cases:

- Sticker collecting - "Jogo da Fruta" Challenge (see use case C.15 on page 101).

B.6 Scenario 6 - Engaging in cooperative activities (with the "Defensores do Espaço" challenge)

During lunch break, Nuno receives a notification that Gabriel is near him and that he might have a missing half of a sticker Nuno is missing. Nuno decides to approach and ask Gabriel about the missing half in order to confirm if he had it or not. Because both were missing each other's halves they decide to do the challenge to acquire them.

The challenge is to play "Defensores do Espaço", a game where each player, each one on their tablet, controls a space ship capable of firing lasers to destroy enemy alien fleets. By eliminating every alien on the fleet they win. After doing so both are awarded the sticker half they were missing for that sticker.

Scenario describes how the application can be used to help Nuno and Gabriel fulfill the following use cases:

- Sticker collecting - "Defensores do Espaço" Challenge (see use case C.16 on page 102).

The following scenarios (B.7, B.8, B.9, B.10) represent interactions which are not supported by the developed proof of concept but are considered as interesting addition for future developments of this work.

B.7   Scenario 7 - Communicating through pictograms

Érica discovered pictograms and their importance in communication while watching a movie about autism. She wants to try to communicate with Nuno by using pictograms and to do so she goes to her tablet and chats with Nuno through the use of pictograms available in the chat function.

Scenario describes how the application can be used to help Èrica fulfill one use case:

- Communicate through the use of pictograms (see use case C.18 on page 104).

B.8   Scenario 8 - Communicating through pictograms (translation)

While switching messages with Nuno, Gabriel received a pictogram from him. Although he is aware that Nuno sometimes communicates through the use of pictograms, Gabriel is not always able to interpret them. By turning the option "Translate Pictograms" on, the pictogram is replaced by text expressing the meaning of the pictogram. Gabriel is able to continue messaging Nuno without interruptions.

Scenario describes how the application can be used to help Gabriel fulfill the following use cases:

- Communicate through the use of pictograms (see use case C.18 on page 104).

B.9   Scenario 9 - Assistance in engaging in a conversation

Nuno enters class where he sees his new classmate, Èrica. He decides to introduce himself to Èrica after the class is over but is unsure what is the best way to do so. After the class is over he goes to his tablet and accesses the "Social Interaction Assistant" option where he is quickly reminded about the initial steps and rules to follow when trying to engage in a conversation with a new person. Afterwards Nuno engages Èrica and makes a new friend.

Scenario describes how the application can be used to help Nuno fulfill the following use cases:

- Be reminded of basic social interaction rules (see use case C.17 on page 103).

B.10   Scenario 10 - Organizing a team based exercise

Today, Sofia's class will be related to the "Portuguese Age of Discovery" and she is thinking about organizing a team based exercise with her students in order to make the class more interactive and to better understand how her students act as a team. To do so, Sofia goes to her computer and selects the "Treasure Hunt" option, where she is shown a map of the school

that she can place multiple treasure chests on and assign them to different teams of students for them to find. She takes her students outside and initiates the activity.

Scenario describes how the application can be used to help Sofia fulfill one use case:

- Organize a team based exercise.

Appendix C

Use Cases

C.1 Use Case: *See own profile.*

User: Érica Beatriz

User Action	Application	User's Device
Selects her picture.	Redirects user to the profile page and acquires user related information (name, age and description).	Displays acquired information.

C.2 Use Case: *Edit profile description.*

User: Érica Beatriz
Continuing from use case C.1: *See own profile.*

User Action	Application	User's Device
...	...	...
Selects "Editar Perfil" button.		Displays text input window with current description.
Selects "Guardar" button.	Saves description in database.	Displays profile page with the updated description.

C.3 Use Case: *See friend's profile.*

User: Érica Beatriz

User Action	Application	User's Device
Selects friend's picture.	Redirects user to the friend profile page and acquires friend related information (name, age and description).	Displays acquired information.

C.4 Use Case: *See friend's location on the school yard.*

User: Gabriel Pereira

User Action	Application	User's Device
Selects "Onde estão os meus amigos?" option.	Redirects user to the "Onde estão os meus amigos?" page and acquires information related to his and his friends' location, avatar and name.	Displays a top view of the school perimeter with the icons and locations of the user and his friends.

C.5 Use Case: *See friend's sticker collection.*

User: Gabriel Pereira
Continuing from use case C.4: *See friend's location on the school yard.*

User Action	Application	User's Device
...	...	...
Clicks on friend's avatar.	...	Displays popup with options "Ver perfil" and "Ver colecção de cromos".
Selects "Ver colecção de cromos" option.	Redirects user to the his friend's sticker collection page and acquires information related the friend's sticker collection (how many stickers there are in the ongoing collection and which parts of the stickers he already obtained).	Displays acquired information.

C.6 Use Case: *Inviting a friend through the friend's sticker collection.*

User: Gabriel Pereira
Continuing from use case C.5: *See friend's sticker collection.*

User Action	Application	User's Device	Friend's Device
...	...	...	...
Selects an incomplete sticker.		Displays confirmation message to send invitation to the owner of the displayed sticker collection to form a team and complete the selected sticker.	
Confirms invitation.	Sends invite to the owner of the displayed sticker collection.	Displays loading feedback.	Displays invitation request to form a team and complete the sticker selected by the requester.

C.7   Use Case: *See own sticker collection.*

User: Nuno Rocha

User Action	Application	User's Device
Selects "Caderneta de Cromos" option.	Redirects user to the "Caderneta de Cromos" page and acquires information related to his sticker collection (how many stickers there are in the ongoing collection and which parts of the stickers he already obtained).	Displays acquired information.

C.8   Use Case: *Get additional information regarding the sticker collection.*

User: Nuno Rocha
Continuing from use case C.7: *See own sticker collection.*

User Action	Application	User's Device
...	...	...
Selects the information icon.		Displays additional information regarding the sticker collection page, from each sticker division into two parts to the meaning of the circles in the middle of the stickers.

C.9   Use Case: *Inviting a friend through own sticker collection.*

User: Nuno Rocha
Continuing from use case C.7: *See own sticker collection.*

User Action	Application	User's Device	Friend's Device
...	...	...	...
Selects an incomplete sticker.	Redirects user to the teammate selection page, retrieving information regarding the users that can help him obtain the missing part of the selected sticker, such as their location.	Displays a map with the icons and locations of the users that can help the user.	
Selects a user's icon.		Displays confirmation message to send invitation to the selected user to form a team and complete the selected sticker.	
Confirms invitation.	Sends invite to the selected user.	Displays loading feedback.	Displays invitation request to form a team and complete the sticker selected by the requester.

C.10   Use Case: *Accept challenge.*

User: Nuno Rocha
Continuing from use case C.9: ***Inviting a friend through own sticker collection.***

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
	Inserts both users in a team and randomly selects challenge, redirecting both users to the challenge instruction page.	Displays invitation request response.		Accepts invite.
Accepts challenge.	Redirects the users to the challenge page.	Displays challenge instructions and asks the user to accept it.	Displays challenge instructions and asks the user to accept it.	Accepts challenge.

C.11 Use Case: *Sticker collecting - "Jogo da Memória" Challenge.*

User: Gabriel Pereira

Continuing from use case C.10: **Accept challenge.**

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
		Displays a set of 4 cards, each with a figure (there are 2 different figures, every 2 cards share the same image), placed upside down.	Displays a set of 4 cards, each with a figure (there are 2 different figures, every 2 cards share the same image), placed upside down.	
Selects card number 1	Saves information regarding which card was flipped and waits for another card to be flipped.	Flips card number 1	Flips card number 1	
	Saves information regarding which card was flipped and compares if the images of both flipped cards are the same (they are).	Flips card number 3	Flips card number 3	Selects card number 3

	Saves information regarding which card was flipped and waits for another card to be flipped.	Flips card number 2	Flips card number 2	Selects card number 2
Selects card number 4	Saves information regarding which card was flipped and compares if the images of both flipped cards are the same (they are).	Flips card number 4	Flips card number 4	
Input answer to the question and confirm.		Displays randomly selected question related to a favorite interest of the current user (same question for both teammates).	Displays randomly selected question related to a favorite interest of the current user (same question for both teammates).	Input answer to the question and confirm.
Input answer to the question and confirm.	Matches answers of each teammate regarding their previous answers and verifies if they answered correctly (answers are correct, teammate 1 answer to question 2 equals teammate 2 answer to question 1, teammate 2 answer to question 2 equals teammate 1 answer to question 1).	Displays followup question regarding the same theme but related to the answer given by the teammate to the previous question.	Displays followup question regarding the same theme but related to the answer given by the teammate to the previous question.	Input answer to the question and confirm.

Confirms sticker part addition to the collection.	Redirects team to the reward page and adds their missing part of the sticker selected in the beginning to their collection.	Displays both sticker parts clearly, not blurred anymore.	Displays both sticker parts clearly, not blurred anymore.	Confirms sticker part addition to the collection.

C.12 Use Case: *Sticker collecting - "Jogo do Tesouro" Challenge.*

User: Nuno Rocha

Continuing from use case C.10: ***Accept challenge.***

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
	Retrieves the current position of both the teammates and the treasure.	Displays a map with the position of both teammates and the treasure location.	Displays a map with the position of both teammates and the treasure location.	
	Retrieves the current position of both the teammates and verifies if both teammates are in range of the treasure chest (they are not in range).			
Input answer to the question and confirm.	Retrieves the current position of both the teammates and verifies if both teammates are in range of the treasure chest (they are in range). Stores answers.	Displays randomly selected question related to a favorite interest of the current user (same question for both teammates).	Displays randomly selected question related to a favorite interest of the current user (same question for both teammates).	Input answer to the question and confirm.

Input answer to the question and confirm.	Matches answers of each teammate regarding their previous answers and verifies if they answered correctly (answers are correct, teammate 1 answer to question 2 equals teammate 2 answer to question 1, teammate 2 answer to question 2 equals teammate 1 answer to question 1).	Displays followup question regarding the same theme but related to the answer given by the teammate to the previous question.	Displays followup question regarding the same theme but related to the answer given by the teammate to the previous question.	Input answer to the question and confirm.
Confirms sticker part addition to the collection.	Redirects team to the reward page and adds their missing part of the sticker selected in the beginning to their collection.	Displays both sticker parts clearly, not blurred anymore.	Displays both sticker parts clearly, not blurred anymore.	Confirms sticker part addition to the collection.

C.13 Use Case: *See friend's interests.*

User: Nuno Rocha
Continuing from use case C.3: *See friend's profile.*

User Action	Application	User's Device
...	...	...
Selects the "Interesses" option.	Retrieves information related to the friend's interests.	Displays acquired information.

C.14   Use Case: *Sticker collecting - "Jogo do Sério" Challenge.*

User: Nuno Rocha
Continuing from use case C.10: ***Accept challenge.***

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
Looks at the tablet as instructed, trying to look into the friend's eyes on the screen, trying not to laugh.	Live streams the content being captured by the tablet's front camera to the friend's device. Receives the live stream from the friend's device.	Displays the live stream from the friend's device.	Displays the live stream from the user's device.	Looks at the tablet as instructed, trying to look into the user's eyes on the screen, trying not to laugh.
	Verifies if smiles are detected in any of the streams (they are not) and if the eyes are still looking at the same quadrants in both devices (they are). The timer of the challenge ends.			
Confirms sticker part addition to the collection.	Redirects team to the reward page and adds their missing part of the sticker selected in the beginning to their collection.	Displays both sticker parts clearly, not blurred anymore.	Displays both sticker parts clearly, not blurred anymore.	Confirms sticker part addition to the collection.

C.15   Use Case: *Sticker collecting - "Jogo da Fruta" Challenge.*

User: Nuno Rocha
Continuing from use case C.10: *Accept challenge.*

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
Taps the fruits through the tablet screen as instructed.	Gathers both player scores.	Displays the fruits falling, as well as his score.	Displays the fruits falling, as well as his score.	Taps the fruits through the tablet screen as instructed.
Input answer to the question and confirm.	The fruits stop falling down and verifies if both teammates got the minimum amount of points required to win. Stores answers.	Displays randomly selected mathematical question involving both player's' scores (same question for both teammates).	Displays randomly selected mathematical question involving both player's' scores (same question for both teammates).	Input answer to the question and confirm.
Confirms sticker part addition to the collection.	Verifies if they answered correctly (they did). Redirects team to the reward page and adds their missing part of the sticker selected in the beginning to their collection.	Displays both sticker parts clearly, not blurred anymore.	Displays both sticker parts clearly, not blurred anymore.	Confirms sticker part addition to the collection.

C.16 Use Case: *Sticker collecting - "Defensores do Espaço" Challenge.*

User: Nuno Rocha
Continuing from use case C.10: ***Accept challenge.***

User Action	Application	User's Device	Friend's Device	Friend Action
...	...	...	...	...
Taps the screen to move the spaceship and fire beams through the tablet screen as instructed.	Verifies if the alien fleet has been fully destroyed (it is).	Displays the remaining enemy alien fleet and both the user's and his teammate spaceships.	Displays the remaining enemy alien fleet and both the user's and his teammate spaceships.	Taps the screen to move the spaceship and fire beams through the tablet screen as instructed.
Confirms sticker part addition to the collection.	Verifies if they answered correctly (they did). Redirects team to the reward page and adds their missing part of the sticker selected in the beginning to their collection.	Displays both sticker parts clearly, not blurred anymore.	Displays both sticker parts clearly, not blurred anymore.	Confirms sticker part addition to the collection.

The following use cases (C.17, C.18, C.18, C.19) represent interactions which are not supported by the developed proof of concept but are considered as interesting addition for future developments of this work.

C.17   Use Case: *Be reminded of basic social interaction rules.*

User: Nuno Rocha

User Action	Application	User's Device
Selects "Social Interaction Assistant" option.	Acquires available interaction options.	Displays available interaction options.
Selects the "How to start a basic conversation" option.		Displays a brief tutorial and challenge on how to start a basic conversation.
Successfully completes the challenge.		Displays successful message.

C.18 Use Case: *Communicate through the use of pictograms.*

User: Érica Beatriz

User Action	Application	User's Device	Friend Device	Friend Action
Selects friend from main screen.	Retrieves friend's information.	Displays friend's profile.		
Selects the "Chat" option.	Retrieves conversation history.	Displays conversation.		
Selects the "Pictogram" option near the text area.		Displays panel with different pictograms.		
Selects the desired pictograms and selects "Send".	Sends message to friend, displaying a notification on the friend's device if he is not in the conversation screen.	Displays message sent.	Receives the notification. Displays the received message with pictograms.	Selects the notification.
	Pictogram is replaced by text expressing its meaning.	Displays message sent.	Displays the message received as text expressing the meaning of the pictogram(s) received.	Toggles the "Translate Pictograms" button.

C.19 Use Case: *Organize a team based exercise.*

User: Sofia Rodrigues

Teacher Action	Application	Teacher's Device	Class Student's Device	Class Student's Action
Selects "Treasure Hunt" option.	Acquires the teacher's classes.	Displays teacher's classes.		
Selects the class 4A.	Acquires student information regarding class 4A.	Displays the team creation interface.		
Selects the number of teams, the number of members per team and assigns students randomly to them.	Generates the different teams.	Displays teams and the available maps.		
Selects the desired area of the school map where the activity will take place.		Displays the desired area.		
Selects the places on the map where a treasure will be hidden.	Saves the treasure locations.	Chosen locations appear as "X".		

Teacher Action	Application	Teacher's Device	Class Student's Device	Class Student's Action
Confirms the activity by selecting the "Confirm" option.	Creates a new map per treasure based on its location and divides it by the number of team members.	Displays the generated maps and associated teams.	Notifies the associated users about the treasure hunt.	
	Retrieves information regarding the user's current team and the part of the map he was assigned.	Displays the generated maps and associated teams.	Displays the acquired information.	Click the notification.
			Displays the complete map.	Find their teammates and join each part of the map they received. They find the treasure location and successfully reach it.
	Redirects team to the reward page and adds a brand new sticker part to their collection.		Displays the complete map. Displays a brand new sticker part.	Confirms sticker part addition to the collection.

Appendix D

Message Type Structures

Messages exchanged between devices allow for users to invite each other and are responsible to synchronize the challenge state on the teams' devices.

D.1 Message Models and Types

There are three message models. These models are reused for multiple types of messages where the same field types that make up the model are required.

Message Model: *Basic*

```
Basic Message Model:
    SenderId
    RecipientId
    Type
    Timestamp
```

This model is called "Basic" since it defines the base structure for the rest of the models, its fields represent:

- SenderId - The id of the user that sent the message;

- RecipientId - The id of the user to which this message is addressed to;

- Type - The type of message it belongs to, triggering different actions according to it;

- Timestamp - Date and time at which the message was sent by the server to the target device.

Message Model: *Invite*

```
Invitation Message Model:
    SenderId
    RecipientId
    Type
    TimeStamp
    SenderName
    SenderAvatar
    Reward
    ChallengeId
    QuestionId
    Question1
    Question2
    Category
```

This model is called "Invitation" since it defines the structure that only invite requests (type "Request") must follow, its fields represent:

- SenderId - The id of the user that sent the message;

- RecipientId - The id of the user to which this message is addressed to;

- Type - The type of message it belongs to, triggering different actions according to it;

- Timestamp - Date and time at which the message was sent by the server to the target device;

- SenderName - The name of the user that sent the message;

- SenderAvatar - The avatar of the user that sent the message;

- Reward - The image and id of the sticker being rewarded on challenge completion;

- ChallengeId - The id of the randomly chosen challenge the team will have to surpass;

- QuestionId - The id of the set of questions the user will have to answer;

- Question1 - The first question the user will have to answer;

- Question2 - The second question the user will have to answer;

- Category - The category to which the set of questions belongs to.

Message Model: *Answer*

```
Answer Message Model:
    SenderId
    RecipientId
    Type
    Answer
    TimeStamp
```

Although this model is called "Answer" it is used for a variety of message types, since it is often convenient to send a message with the basic structure alongside an additional text field attached, its fields represent:

- SenderId - The id of the user that sent the message;

- RecipientId - The id of the user to which this message is addressed to;

- Type - The type of message it belongs to, triggering different actions according to it;

- Answer - A text field which the values depends on the type of message;

- Timestamp - Date and time at which the message was sent by the server to the target device.

- -

Message Type: "*Answer1*"

When the field "Type" of a message has the value "Answer1" the system interprets the value of the field "Answer" as the answer to the first question asked after completing either reaching the treasure in the "Jogo do Tesouro" challenge or successfully completing the first part of the "Jogo da Memória" challenge. This field is used by the system to compare if the answer given by the user to the second answer is the same as the answer given by the user's teammate to the first question.

- -

Message Type: "*FirstFlip*"

When the field "Type" of a message has the value "FirstFlip" the system interprets the value of the field "Answer" as a change in the game state of the first part of the "Jogo da Memória" challenge. This change informs the system that the first card, which is identified by the value on the field "Answer", has been flipped and the system is now waiting for the other user to flip the other card.

- -

Message Type: "*Match*"

When the field "Type" of a message has the value "Match" the system interprets the value of the field "Answer" as a change in the game state of the first part of the "Jogo da Memória" challenge. This change informs the system that the second, which is identified by the value on the field "Answer", has been flipped and it is equal to the first one, making a match.

- -

Message Type: "*NoMatch*"

When the field "Type" of a message has the value "NoMatch" the system interprets the value of the field "Answer" as a change in the game state of the first part of the "Jogo da Memória" challenge. This change informs the system that the second, which is identified by the value on the field "Answer", has been flipped and it is not equal to the first one, flipping over those same cards to their original state.

Appendix E

First Iteration Heuristic Evaluation

Heuristic: *Flexibility and efficiency of use*

- -

User 1 reported that, when on the sticker collection page, it should be possible to click directly on the avatar of the friends that can help a user obtain the other part of a sticker and invite them from that page, skipping the step of locating each potential teammate on the map and inviting them from there.

This problem was given a **severity of 1**.

Although such a change would in fact make the process of inviting a user to form a team faster, skipping that step would defy one of the core objectives of the feature, which would allow for users to invite each other without needing to be close to one another. The map is shown so that the user might see where his potential teammates are, giving him a notion if he can invite them or if he still needs to get closer to them in order to do so.

- -

User 4 reported that in the home page, instead of scrolling through my friends by clicking the arrow, it would be better to have a page to list all of them.

This problem was given a **severity of 2**.

Because the scenario only incorporated the new features, users were not able to interact with the older ones. One of the original features of **AMICA** is in fact to display all the friends a user has.

- -

User 4 reported that displaying the count of how many stickers a friend has that I do not have, and which are they, could be additional information to appear on their profile.

This problem was given a **severity of 1**.

Although this is information that could speed up the process when deciding to see or not a friend's sticker collection, we believe that, by making a user go to another friend's collection

page and expose him to other friends that can also help that friend, aside from the current user, might motive the user to interact with him, to maybe inform the friend of other potential teammates.

- -

User 4 reported that, assuming the map of the school would be draggable, it would be better to display, when clicking a friend's avatar or by viewing their profile, in what zone of the school they were to make the process more efficient.
This problem was given a **severity of 2**.

Although the map is not draggable, meaning that the user is limited to the top view of the school, dividing the map of the school in sectors and placing the friends' avatar in a certain sector not displaying their actual position is a very interesting idea, since it could potentially make the user interact with more friends, instead of knowing that there is someone in a specific position he now knows that there are multiple friends in a sector but not where exactly.

Heuristic: *Visibility of system status*

- -

User 3 reported that just by looking at the map displayed while inviting a friend to form a team, it is not clear if the user is close enough to that friend without clicking on his avatar and receiving a message displaying that information.
This problem was given a **severity of 2**.

By clearly showing the user if he is or not in range to invite another user is important visual feedback, avoiding possible unnecessary interactions with the application.

- -

User 4 reported that, while on the main page of the application, it was not possible to see information associated with each option.
This problem was given a **severity of 2**.

Although this information is already present on **AMICA**, it was not represented in the prototype.

Heuristic: *Recognition rather than recall*

- -

User 2 reported that, since the only way to access a user's sticker collection is by going to their profile, by clicking the "Caderneta de Cromos" button from the home page, it should be possible to see other users' sticker collection, as well as our own. User 2 also mentions that the current behaviour might lead to recall rather than recognition.

This problem was given a **severity of 2**.

Although this is true, we feel that adding more sticker collections to that page other than the user's could make the interface more complex, possibly confusing the user.

Heuristic: *User control and freedom*

- -

User 4 reported that it was only possible to find users inside the school area.
This problem was given a **severity of 3**.

This is the intended behaviour. Although it would be interesting to promote social interaction outside of school, we do not want to expose the user when he is not inserted in an application ready environment.

Heuristic: *Aesthetic and minimalist design*

- -

User 4 reported that the map is too small.
This problem was given a **severity of 1**.

The map could in fact occupy more space of the page.

Appendix F

Cognitive Walkthrough with Therapists

Tarefas

Nas tarefas descritas em baixo irá utilizar a aplicação através da conta do utilizador Nuno Rocha, uma criança com perturbação do espectro do autismo, inserida na escola onde todos os colegas têm também um tablet com acesso a aplicação AMICA.
É também pedido que avalie cada tarefa consoante a dificuldade que teve na sua execução:

- **1 - Muito Fácil;**
- **2 - Fácil;**
- **3 - Difícil;**
- **4 - Muito Difícil.**

Tarefa #	Objetivo	Grau de Dificuldade de Execução (1-4)
Tarefa 1	Verificar se tenho o cromo do lobo	1
Tarefa 2	Verificar o número dos cromos que ainda não completei	1
Tarefa 3	Obter uma nova parte do cromo número 3	2
Tarefa 4	Obter uma nova parte do cromo número 4	2
Tarefa 5	Ver onde estão os colegas de turma na escola.	1
Tarefa 6	Ver a descrição de um colega de turma	2
Tarefa 7	Ver os cromos que um colega tem	2
Tarefa 8	Identificar que partes de cromos é que o colega tem e eu também	4
Tarefa 9	Identificar que partes de cromos é que o colega tem que eu não tenho	4
Tarefa 10	Identificar que partes de cromos é que eu tenho que o colega não tem	4
Tarefa 11	Identificar que partes de cromos é que eu posso obter	4
Tarefa 12	Obter uma nova parte do cromo número 5	2
Tarefa 13	Obter uma nova parte do cromo número 7 através da caderneta de um colega	2

Tarefas

Nas tarefas descritas em baixo irá utilizar a aplicação através da conta do utilizador Nuno Rocha, uma criança com perturbação do espectro do autismo, inserida na escola onde todos os colegas têm também um tablet com acesso a aplicação AMICA.

É também pedido que avalie cada tarefa consoante a dificuldade que teve na sua execução:

- **1 - Muito Fácil;**
- **2 - Fácil;**
- **3 - Difícil;**
- **4 - Muito Difícil.**

Tarefa #	Objetivo	Grau de Dificuldade de Execução (1-4)
Tarefa 1	Verificar se tenho o cromo do lobo	2
Tarefa 2	Verificar o número dos cromos que ainda não completei	2
Tarefa 3	Obter uma nova parte do cromo número 3	2
Tarefa 4	Obter uma nova parte do cromo número 4	2
Tarefa 5	Ver onde estão os colegas de turma na escola.	2
Tarefa 6	Ver a descrição de um colega de turma	2
Tarefa 7	Ver os cromos que um colega tem	2
Tarefa 8	Identificar que partes de cromos é que o colega tem e eu também	4
Tarefa 9	Identificar que partes de cromos é que o colega tem que eu não tenho	4
Tarefa 10	Identificar que partes de cromos é que eu tenho que o colega não tem	4
Tarefa 11	Identificar que partes de cromos é que eu posso obter	4
Tarefa 12	Obter uma nova parte do cromo número 5	4
Tarefa 13	Obter uma nova parte do cromo número 7 através da caderneta de um colega	4

Tarefas

Nas tarefas descritas em baixo irá utilizar a aplicação através da conta do utilizador Nuno Rocha, uma criança com perturbação do espectro do autismo, inserida na escola onde todos os colegas têm também um tablet com acesso a aplicação AMICA.

É também pedido que avalie cada tarefa consoante a dificuldade que teve na sua execução:

- **1 - Muito Fácil;**
- **2 - Fácil;**
- **3 - Difícil;**
- **4 - Muito Difícil.**

Tarefa #	Objetivo	Grau de Dificuldade de Execução (1-4)
Tarefa 1	Identificar que partes de cromos é que o colega tem	2
Tarefa 2	Identificar que partes de cromos é que o colega não tem	2
Tarefa 3	Identificar que partes de cromos é que eu posso ajudar o colega a completar	2
Tarefa 4	Identificar que partes de cromos é que eu não posso ajudar o colega a completar	2
Tarefa 5	Obter uma nova parte do cromo número 2 através da caderneta de um colega	2

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